OCTOBER 1958

Agricultural Engineering

The Journal of the American Society of Agricultural Engineers

ND FACTS

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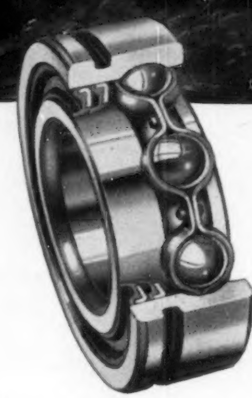
LUBRICATED-FOR-LIFE DISC BEARINGS CUT MAINTENANCE ON PLOWS

Disc plows mounted with New Departure integrally sealed, factory-lubricated ball bearings require NO field servicing. In fact, no grease fitting is provided or even needed. With New Departure ball bearings, discs turn freely, wear evenly and longer. They remain fully adjusted . . . assuring no unplowed furrows. And . . . with field adjustment eliminated, there's never a danger of bearing contamination.

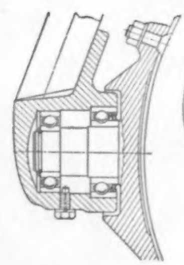


DIMENSIONS

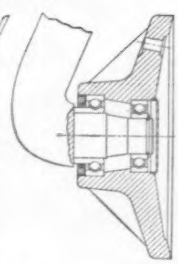
TYPE I — TYPE II — TYPE III

Plow Size*	Position	Bearing Number	Type	Bore B	Diameter D	Width W	Width J
24 RS	Front	905422	I	1.6250	3.2677	1.014	1.024
24 RS	Rear	3207	III	1.3780	2.8346	.669	—
24 SS	Front	3208	III	1.5748	3.1496	.709	—
24 SS	Rear	905422	I	1.6250	3.2677	1.014	1.024
28 RS	Front	4510 A	II	1.9685	3.5433	.787	1.297
28 RS	Rear	3208	III	1.5748	3.1496	.709	—
28 SS	Front	3208	III	1.5748	3.1496	.709	—
28 SS	Rear	4510 A	II	1.9685	3.5433	.787	1.297
32 RS	Front	3L13	III	2.5591	3.9370	.709	—
32 RS	Rear	3210	III	1.9685	3.5433	.787	—
32 SS	Front	3210	III	1.9685	3.5433	.787	—
32 SS	Rear	3L14	III	2.7559	4.3307	.787	—

*RS indicates rotating spindle; SS indicates stationary spindle



Rotating spindle disc plow mounting featuring a two lip integral seal bearing.



Stationary spindle disc plow mounting featuring extended inner race for mounting external seal.

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1908–1958 GM FORWARD FROM FIFTY

NEW DEPARTURE

DIVISION OF GENERAL MOTORS, BRISTOL, CONN.

NOTHING ROLLS LIKE A BALL

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Agricultural Engineering

Established 1920

CONTENTS • OCTOBER, 1958 • Vol. 39, No. 10

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JAMES BASSELMAN, *Editor and Publisher*

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Radio Tribute Planned

THE ASAE will be saluted by Alex Dreier in a tribute to the farm equipment industry and the field of agricultural engineering on a nationwide radio program November 23 at 6:05 (EST) over NBC-Monitor network. Presenting the program as one in a series of its kind honoring American fields of activities, he will also feature the Farm Equipment Institute and the National Retail Farm Equipment Association.

The tribute will tie in with the International Livestock Exposition which begins November 28 in Chicago.

According to reports agricultural engineers will be recognized for remarkable achievement in erosion control, contour farming, terracing and the production of labor-saving machinery. Mr. Dreier also will point out a need for agricultural engineers for research, design, development, testing, management and administration, and will emphasize the many opportunities awaiting the student of agricultural engineering. ASAE members are urged to bring this announcement to the attention of their associates and students.

October — Membership Month

OCTOBER each year is designated as membership month. Members of ASAE are urged, during this month, to make every effort to encourage qualified engineers to apply for membership.

The value of ASAE affiliation is enhanced by the mobilization of professional talent to the mutual advantage of both the members and the Society. An increased membership results in an increased capacity to serve. A profession with continually widening horizons demands the participation of every progressive engineer.

This particular month has been chosen as membership recruiting month since most ASAE Sections begin the year's activities at this time. Applications made during this month will be processed in time to permit full membership status before the next calendar year with new members receiving the advantage of a full year of section meetings and Society benefits. Intellectual as well as social advantages derived from the section and national meetings keep the engineer in touch with current professional progress and the latest technical information relative to his particular field of service.

The growth of the Society depends upon the membership of every qualified engineer engaged in agricultural engineering work. If you are not a member, make October the month for making application for ASAE membership where your profession can serve you best.

Graduate Placement

A PLACEMENT survey of 1958 engineering graduates reported to Engineers Joint Council revealed that 83.5 percent of estimated 33,000 graduates of 1958 were hired a month before graduation. Despite unfavorable economic conditions in the United States, only 10 percent of graduate engineers had no definite plans by late May and, as of June, none were without job offers. In spite of conditions, placement opportunities for new engineers is reported as remarkably stable. Full report is available by writing to Engineers Joint Council, 29 W. 39th St., New York 18, N.Y.

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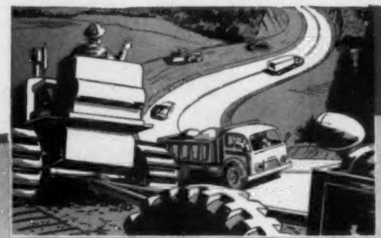
"get the power through" to make our highways come sooner . . .



It's a rough, tough, shock-and-strain life for the average 'dozer and loader. But machines like these are ready for it. Part by part, they've had long life engineered right in from the start.

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UNIVERSAL JOINTS AND DRIVE LINE ASSEMBLIES

Report to Readers . . .

PLASTIC TILE AND TILE LAYER TOOL COMBINE TO PROMOTE MOLE DRAINAGE

It now looks as if "mole" drainage may be about to come into its own as a means of substantially reducing the cost – and thereby increasing the extent – of subsurface land drainage. After some years of research, in collaboration with drainage engineers of USDA, Cornell and other land-grant colleges, one of the principal manufacturers of farm and earth-moving equipment (Caterpillar) has developed an experimental machine which, in addition to a mole plow, includes a device which positions a slitted plastic strip to form an arch lining for a mole drain. (This development was featured in a technical article published in the February issue of this journal.) . . . . The company now reports that it has recently made a significant further improvement in the tile layer. Instead of merely forming an arch for the mole drain, the tile layer is now built to form the ribbon of (Bakelite) vinyl plastic into a tubular shape. The plastic sheet can then be made to hold its shape in the ground either by soil pressure, metal stapling, heat bonding, pressure-sensitive plastic tape, or liquid fastening. All five of these methods of maintaining the round shape of the plastic tile are still under development. . . . Caterpillar technicians estimate that this new technic for laying plastic tile will be tenfold faster than the rate of laying conventional draintile. Incidentally, the USDA estimates that there is a present need in the United States for 1.4 million miles of subsurface agricultural drains.

TRACTOR POWER STEERING CONSERVES DRIVER ENERGY

It's a lot more sensible to put power-steering equipment on tractors than it is on motor cars. The answer is simple: it performs a more important function in conserving drivers' energy. According to tests made by a Purdue University agricultural engineer, the force required for the manual steering of a large row-crop tractor equipped with a manure loader approximated 50 pounds. When the same tractor was equipped with mechanical steering, the effort was reduced by one-third. Again in cultivating corn a large tractor required an 18 to 35-pound effort for conventional steering, but when equipped for power steering, driver effort was reduced to one-third or one-fourth of that amount. It is reasonable to believe that the demand for power-steering equipment on the larger tractors especially will continue to become increasingly more pressing.

ENGINEERS EXPLORE USE OF REMOTE CONTROL FOR TRACTOR OPERATION

It may well be that latter-day caricaturists, who depict tomorrow's farmer directing operation of his motorized production equipment by remote control from a rocking chair on the front stoop, will one day be credited as genuine apostles of push-button farming. But engineers, too, have long been scouting the possibilities of remote control in the operation of farm equipment, only their approach to making it a practical reality is along the tortuous route of scientific, engineering, and manufacturing exploration. . . . Recently University of Nebraska agricultural engineers demonstrated operation of a farm tractor by remote control. The machine was equipped with electronic devices for starting and stopping the engine and regulating its speed, operating the clutch and brake, shifting gears, steering, and lowering and raising a cultivator mounted on it. The Nebraska engineers envision the possibility of using ultrahigh-frequency radio bands for one-man control of multiple pieces of farm equipment. . . . Engineers concerned with the development, design, application, etc., of implements, machines, equipment to meet the multitude of requirements in farming will be giving more and more attention to developing remote control technics for increasingly wider application. Its development to the point of practical utilization is only a matter of time and application of engineering know-how.

FARMER DEMAND CREATES PRESSURE FOR PROGRESS IN HAY PELLETING TECHNICS

One facet of the great wave of enthusiasm evident this past season in the development of hay pelleting seems especially significant. It is the fact that farmer demand is way out ahead of the ability of the engineers and manufacturers to develop the technics of the pelleting operation and to design and build the machines required for its proper performance. Mechanization of hay storage and feeding has been high on the priority list for several years. So stated a University of California agricultural engineer at the ASAE annual meeting last June, and he went on to point out that the need is for a new hay package that will facilitate mechanical handling and feeding. There appears to be wide agreement that pelleting is the best answer yet offered. The further fact is that, since hay is a comparatively low-value crop,the cost of preparing the new package must be kept low to compete with present methods of processing and packaging. . . . It is clear from this engineer's report that the art of pelleting, while still pretty much in a crude stage of development, is far enough advanced to indicate that hay pelleting costs can be justified on the basis of storage and handling alone. Because of this and in view of the attention that hay pelleting is now receiving, another year of effort should bring even more promising results in producing a more attractive hay package for farm animals.

OBSOLESCENCE OF FARM BUILDINGS CAUSE FOR ALARM SAY ENGINEERS

One result of probing by an ASAE committee looking into the need for research and statistics on farm buildings, was to produce startling evidence of the urgent requirement for more efficient and economical service buildings and more livable farmhouses. The inquiry also revealed that, while the problem of modernizing or replacing obsolete buildings is immense, the waste of time, energy and potential production resulting from their continued use is even greater. . . . The ASAE committee views the situation as critical – in fact, as presenting a tremendous challenge not only to agricultural engineers in public-service agencies (state and federal) but also to administrators and other agricultural specialists of such agencies, and to manufacturers and retailers of buildings, building materials and related equipment. . . . Agricultural engineers are asking themselves if a completely new approach to farm-building design may not be needed. Some are even suggesting that farm buildings, as is true of more and more farm machines, be designed for relatively short life, be correspondingly lower in cost, and be portable, i.e., not a part of the farm real estate. . . . The engineers agree on the great need of research to demonstrate the difference between a good building design and a poor one. One engineer, for example, has combined economic and engineering data to show that feed and labor savings in a good building may amount to much more than the annual cost of the building. . . . In a word, it is important that progress in farm buildings keep pace with the rapid strides of other phases of mechanization in agriculture.

POTATOES GIVEN CUSHIONED RIDE TO AVOID BRUISING AT HARVEST

"The common potato gets luxury treatment . . . ;" that's the way the statement began. It was a fascinating idea, certainly, when one reflects that the lowly spud usually gets pretty rough handling in its travel from hill to storage. Then the story went on to say how science and engineering had combined to give potatoes a real cushioned ride, in the harvester mentioned, as they are taken out of the ground at harvest. . . . The conveyor bars, carry-ups and clod eliminators of this improved harvester (Dahlman) are all cushioned with a sponge-like plastic coating, a polyvinyl chloride material made by Goodrich. This coating is spongy and resilient while having a tough, abrasion-resistant skin – just what is needed for harvesting potatoes that are bruise-free and in otherwise prime condition.

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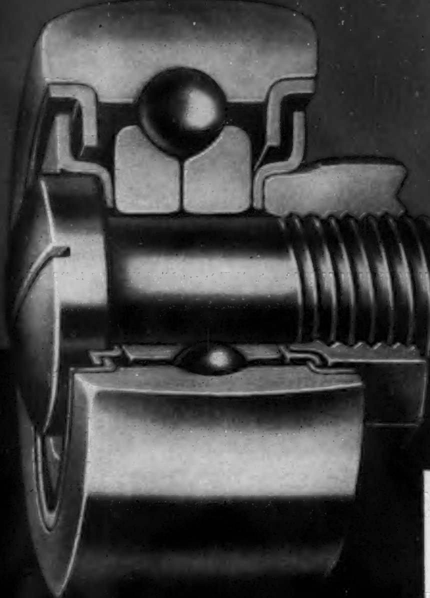

Design and service tested, BCA package units simplify production line installation . . . bring ball bearing costs down to practical levels. Rugged construction plus effective sealing assures long and trouble-free use. BCA is prepared to help with your ball bearing engineering and design problems . . . to provide the "package unit" you need in sample or production quantities. Bearings Company of America Division, Federal-Mogul-Bower Bearings, Inc., Lancaster, Pa.

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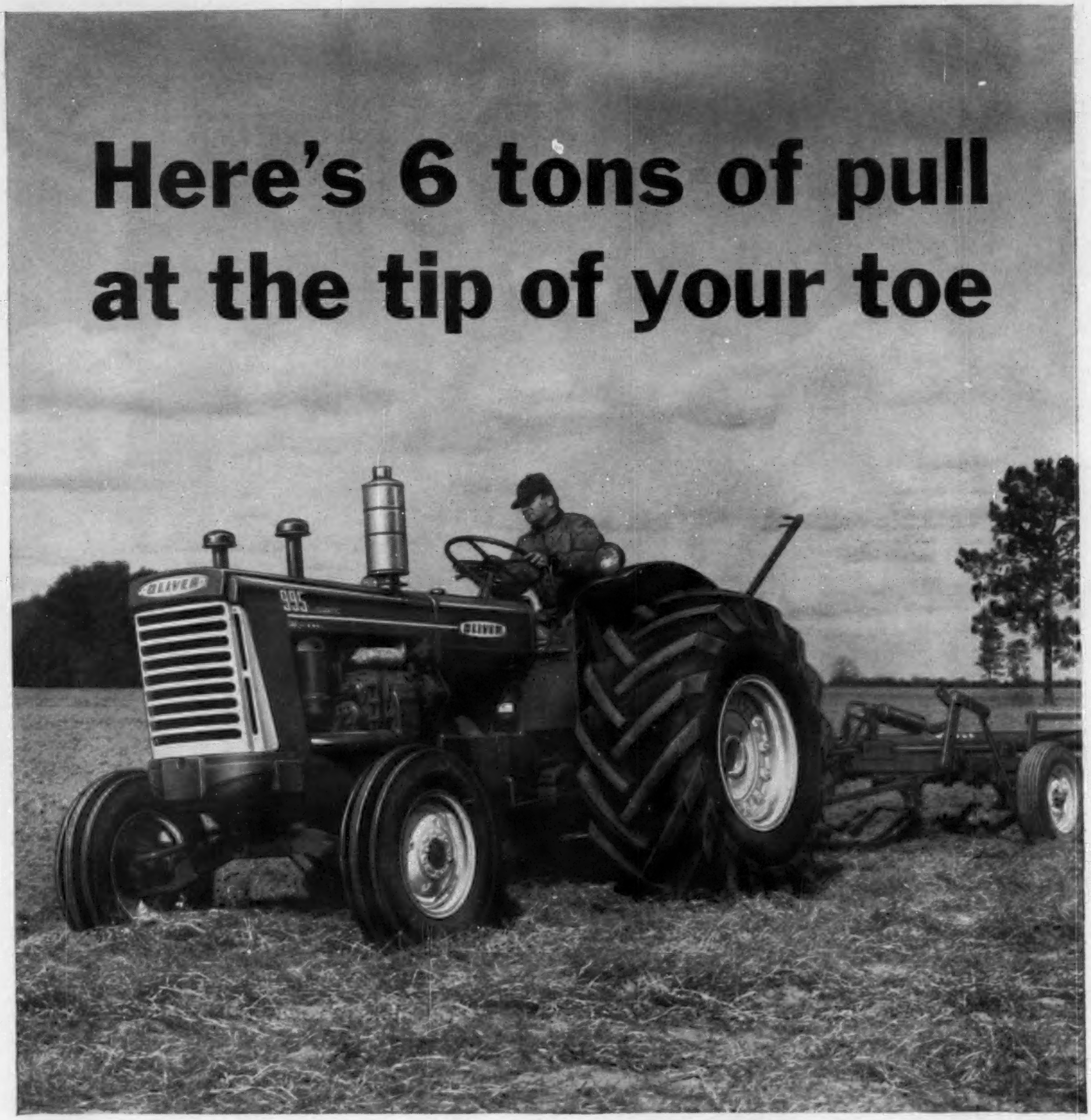

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Here's a tractor that changes all concepts of power because never before has there been so much to call forth. Yes, Oliver power gives farming new muscle, a new way to make heavy-duty operations go faster at less cost.

The Oliver Corporation
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**Actual, recorded maximum pounds of pull in official, nationally recognized tests was 12,538.*

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PERFECT CIRCLE PISTON RINGS

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Agricultural Engineering

October, 1958
Number 10
Volume 39

James Basselman, *Editor*

How Efficient Will Be the Farm Machine of the Future?

Guest Editorial by G. B. Gunlogson, Life Member ASAE

MARKED progress has been made toward increasing the mechanical efficiency of power farming equipment. This includes all major farm machines and tractors with various inbuilt and supplementary features such as power take-off, hydraulic controls, automatic transmission, power steering, etc. The question is how does the over-all efficiency or the effective work output of these machines in the hands of farmers compare with their rated capacity or proving ground performance? As increased mechanical efficiency and higher costs are built into this equipment, it becomes increasingly important to know more about actual field efficiency and to what extent the farmer is utilizing its potential.

Even under good management there is considerable lost time and wasted motion in the use of farm equipment. The difference between the actual work output of a machine during the season compared with its theoretical or rated capacity is the product of a combination of human and machine factors. If we knew more about these factors, whether they are attributable to poor management, shortcomings of the operator or mechanical faults or failures, it would be of great value to farmers as well as to the engineer who is concerned in the future development of farm machinery. More study into these aspects would be most helpful toward attaining greater machine efficiency.

Agricultural Engineers Should Make Field Studies

There have been some field-efficiency studies made. One of these was conducted by K. K. Barnes of Iowa State College and reported in the April, 1956, issue of "Iowa Farm Science." While the scope of the study is limited, it throws a great deal of light on some of the points under discussion and should become more widely known. During the last two years I have corresponded with a number of agricultural engineers in colleges on this subject.

All have expressed interest, and some of them are now considering conducting studies of this kind. They are well aware that the methods and procedures would involve a great deal of planning, a lot of work and considerable expense. The agricultural college appears to be the most logical agency to undertake these projects, and the agricultural engineer is trained to direct the work. Some financial help toward these projects might come from the farm equipment industry or from individual concerns.

When general-purpose tractors began to take over the job of providing power for threshing, I undertook a study into the suitability and efficiency of gas tractors as compared with steam engines for threshing. Based on 97 threshing rigs checked one fall, the loss of grain ranged all the way from an infinitesimal amount to more than 10 percent. The loss of time from one cause or another during scheduled work periods ranged from 7 to 51 percent. The direct causes were usually obvious to the observer, but the reasons for the causes were invariably more significant. For example, the cause for most of the poor work and loss of time was found to be inadequate power for size of the machine and rate of feeding. The problems of adjusting operations and judgment to new methods and new machines will always confront us.

More Information Would Make Present Service Facilities More Effective

There has been a widespread campaign by manufacturers, dealers, farm papers and various agencies to promote better care of farm equipment. It is urged that machines be gone over before being put away to replace needed parts and to have all necessary service work done during off seasons, etc. Dealers also are improving their service facilities and are employing better trained mechanics to do this work and to advise farmers. The effectiveness of these services and educational efforts would be greatly enhanced if more information were available on time and crop losses. By analyzing the facts and causes it might indicate many ways for improving machine efficiency on the farm.

More and more the farmer's income has come to depend on the output of machinery. The amount of crops produced per man has more than doubled since the 'twenties. In the production of the three principal crops — corn, cotton and wheat — man-hours have been reduced from 7,700 million to something like 3,000 million. Wages are about three times higher. The farmer's annual expenditure in power and machinery is many times higher. The quality of work and the whole business of farming have become geared to machinery. Every hour of lost time in field work can be costly. Increasing machine efficiency on a farm ever so slightly may mean the difference between profit and actual loss on that farm.

How Electronic Brains Can Help Engineering Brains Build Better Machines

Now we come to the consideration of another kind of "field study" which only the manufacturer could carry on, since only he has the dealers, sales and service groups capable of feeding the desired information back to the control center. This study would be directed at the design of the machine itself — its engineering and mechanical qualities. It would be a continuous study for evaluating the performance of machines in actual operation during their entire life.

Modern equipment for recording and processing massive data would be essential for handling this work. Electronic data processing equipment now provides the means to evaluate many kinds of engineering data and to plot trends with pinpoint accuracy which before went by educated guessing. With the development of this system as an aid to engineering, it is certain that the useful life of tractors and other major farm machines could be greatly lengthened as compared with present models. Dependability and freedom from mechanical troubles would be proportionally enhanced and the improved engineering *per se* should not add a great deal to the cost of the machine. We have the engineering skill and metallurgical science to accomplish this if we knew more precisely the wear and tear and functional failures against which to engineer.

In the farm machinery industry, manufacturers have evolved elaborate systems of inspection and testing materials and product quality in production. Some have extensive proving grounds for product testing. But all of these are essentially forecasting or precautionary measures. They don't tell what actually happens to the machine in actual operation and at successive stages of its life. The ultimate test of quality does not come until the machine is in the field.

The usual sources and channels for product information are: (1) reports or complaints from users which may come in directly or through dealers; (2) reports on field jobs that may be done by factory mechanics (usually emergency cases); (3) reports on service work done at dealers' shops; (4) records of parts replaced. Additional information on the condition of used machinery is sometimes obtained by clinical studies where old machines are taken down part by part for inspection and study of wear and tear. All this data has engineering value depending on how it is evaluated and utilized.

The system proposed would use basically the same kind of data from the same sources. Some refinements and improvements in the system of reporting might be necessary. It is important that all forms and procedures for reporting be simple, specific and easy to classify. The origin and flow of data should be as near routine and free from personal bias as possible. All this raw material must be evaluated and classified before feeding it into the computer.

The most important phase of the operation is in its programming. Here, millions of facts on parts replaced, on machine fail-

(Continued on page 652)

Editor's Note: The author, G. B. Gunlogson, shortly after receiving his engineering training at the North Dakota Agricultural College, joined the J. I. Case Company, where in the early days of the gas tractor he had charge of the company's tractor schools. Later he served the company as branch manager, director of advertising and sales promotion, and sales manager. In 1927 he joined the Western Advertising Agency as president and is currently serving the agency as chairman of the board.

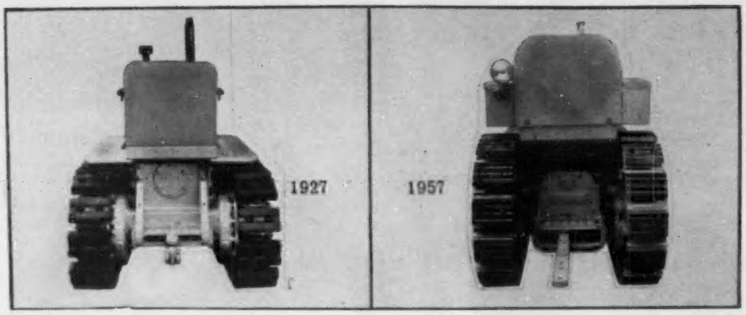


Fig. 1 Track-type tractor design, as illustrated, can change little until a radical change in practice takes place

Performance Improvement in Track-Type Tractors

M. G. Bekker
Member ASAE

Articulation of units and redesign of component parts (based on soil measurement research) show promise as means for improved performance

TRACK-TYPE tractors have not radically changed since 1905, when the Messrs. Hornsby introduced the steering concept which requires a fixed width-length ratio (Fig. 1). Since that time the thrust/weight and drawbar-pull/weight ratios of the vehicle have remained practically constant. This must be considered a serious disadvantage, as will be discussed in the following paragraphs.

Paper presented at the 51st Annual Meeting of the American Society of Agricultural Engineers at Santa Barbara, Calif., June 1958, on a program arranged by the Power and Machinery Division. Article and photographs have been produced with permission of the Ordnance Tank-Automotive Command.

The author — M. G. BEKKER — is chief, Land Locomotion Research Branch, Research and Development Division, Ordnance Tank-Automotive Command, Detroit, Mich.

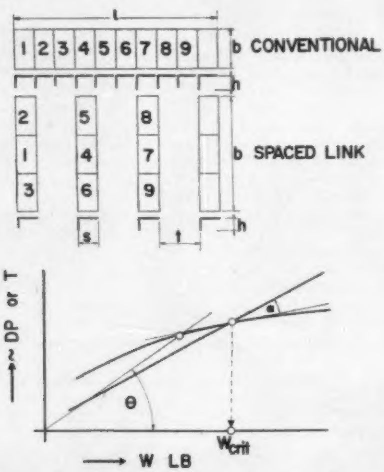


Fig. 2 Thrust of a track is improved over conventional track when cleats are spaced as indicated.

Studies originated more than 10 years ago under the auspices of the Canadian National Research Council and developed subsequently by the United States Army Ordnance Corps led to the development of a theory of soil-vehicle relationship (1)*.

This theory has suggested a new way of improving tractor performance by either increasing their drawbar pull without changing the weight or by reducing weight of the tractor without loss of pull.

The equation which relates thrust T of the conventional tractor to its weight W, soil friction ϕ, cohesion c, and ground pressure p may be written in this form:

$$T/W = c/p + \tan\phi \qquad [1]$$

It results from this equation that further increase of T/W is impossible without a further decrease of p. Since the ground pressure undoubtedly has reached the ultimate, there has been little change for past decades; the present design trend illustrated by equation [1] and Fig. 1 appears to have reached its end—no radical improvement can be expected without a radical departure from present practice.

However, if the cleats of the track are spaced apart in an appropriate way, then the thrust may be expressed by the following equation [1]:

$$T = 2Nb\,(csn_c + \gamma s^2 n_\gamma)\sin\theta \qquad [2]$$

where N is the number of cleats of one track laying on the ground; b is the track width; s is the length of the cleat; n_c and n_γ are coefficients depending on soil friction ϕ and cleat dimensions. These coefficients were tabulated in reference(1). $T/W = \tan\theta$.

Take, for comparison, a conventional track composed of cleats 1, 2, 3, 4, 5, 6, 7, 8, 9, etc., and place cleats 2 and 3, 5 and 6, 8 and 9, etc., on both sides of cleats 1, 4 and 7

*Numbers in parentheses refer to the appended references.

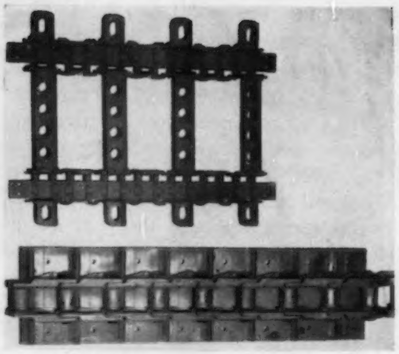
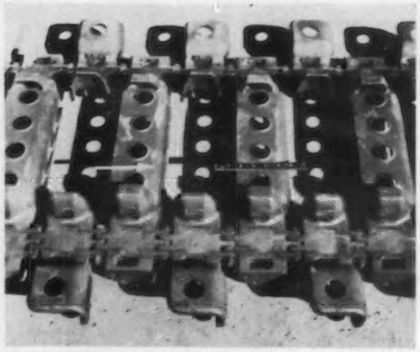


Fig. 3 *(Left)* Thrust increases of 100 percent were reported for spaced-link track *(above)* over conventional track • Fig. 4 *(Right)* An experimental track recently tested



etc. which remain in their original position (Fig. 2). If the spacing is properly defined(1), the thrust of such a track will be superior to that of a conventional track within definite load limits, as computations performed by means of equations [1] and [2] show.

If the spacing is smaller than a certain theoretical value determined from reference (1), the spaced-link track thus obtained will behave in most frictional soils (those commonly prevailing in agriculture and road construction), as a conventional track. An explanation of this phenomenon is similar to that known in soil mechanics under the term of "arching effect"(3).

In general, it has been demonstrated that, in order to obtain the conventional thrust, it is not necessary to build tracks composed of a continuous chain of closely mounted cleats. Wide gaps in those chains do not necessarily lower track performance. On the contrary, an appropriate spacing of track cleats is essential to improve the thrust. Thus a spaced-link track as described in Fig. 2 will be superior to the conventional one in most cases.

Results were tested in the field by means of experimental full-size vehicles, including one agricultural tractor. Tests showed thrust increases of the order of 100 percent. A comparison between a spaced-link and conventional track is shown in Fig. 3. One of the experimental tracks is shown in Fig. 4; a bellyless, spaced-link, tracked vehicle developed by the U.S. Ordnance Corps is shown in Fig. 5.

A general explanation of the fact that empty spaces between cleats produce thrust and carry the load is shown in Fig. 6. In this figure the rear cleat, which is close to its neighbor, shears the soil—as the well-distinguishable disruption of soil particles shows—in a shallow short volume. However, the front cleat, unobstructed by another one, shears soil within a deep and far extending soil volume.

It may be demonstrated that the shallow shear produces less thrust than the deep shear. Thus, the front cleat contributes more to the pull of the considered two cleat "track" than the rear one. Accordingly, it is essential to space the cleats in such a way as required to avoid their mutual obstructing of shear pattern(1, 4).

Equation [2] indicates that thrust may be increased to any desired amount if the number and size of the cleats is increased. This requires the lengthening of the track. But,

Fig. 5 Shown is a bellyless, spaced-link, tracked vehicle developed by the U.S. Ordnance Corps

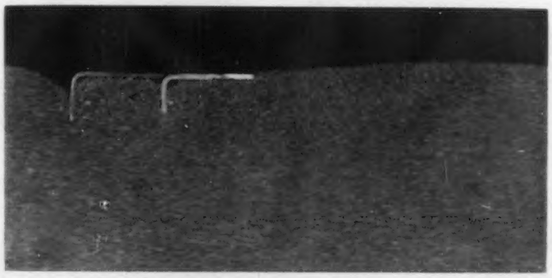


Fig. 6 Thrust advantages are dramatically illustrated. The rear cleat, which is close to the first, shears the soil in a shallow, short soil volume. The front cleat shears soil within a deep and far extending volume

Fig. 7 Miniature scale vehicles were used for many tests

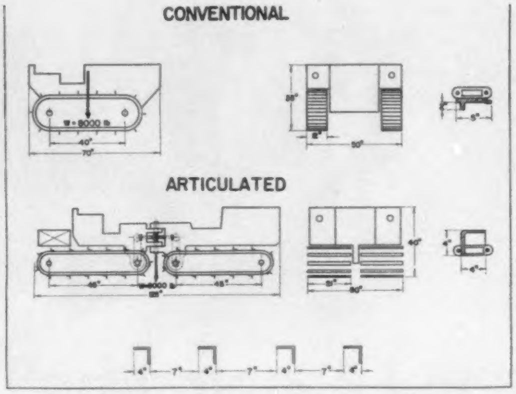


Fig. 8 Comparison between a two-unit tractor and conventional tractor

the conventional vehicle cannot be elongated beyond a certain length/width ratio because it would not steer.

However, the potential gains in drawbar pull produced by the application of the spaced-link track convinced this author that a radical departure from the half-century tradition may be advisable. Accordingly, abandonment of the present steering concept and the use of a tractor composed of two or three self-propelled units steered by pivoting each unit around the joint was suggested some time ago(1). A general elaboration of that concept, termed the "train concept," was described elsewhere(5).

Tests performed by the author in 1949-51 with a scale model of such a vehicle (Fig. 7) and the latest experience with full size vehicles of this type developed by Canadair, a subsidiary of General Dynamics Corporation, and the U.S. Transportation Corps, in cooperation with Wilson Nuttall & Raymond Engrs. Inc., seem to confirm all the expectations.

General concept and potential gains of articulated spaced-link tractors are illustrated in Figs. 8, 9, and 10. Fig. 8 shows a sketch of a two-unit tractor as compared to a conventional one.

Experiments and computations performed in accordance with the discussed theory (1, 5) show that the improvement of pull would be of the order of 52 percent in a sandy soil and of the order of 112 percent in a cohesive (sticky) soil if the conventional tractor is replaced by the spaced-link articulated one.

Fig. 9 shows a three-unit tractor. Performance curves of that tractor and of the comparable conventional tractor are shown in Fig. 10. In soil having friction of 39 deg and cohesion of 0.3 psi, a 10,000 lb conventional tractor similar to that shown in Fig. 8 will pull only 9,900 lb while the considered spaced-link articulated tractor of the same weight will pull 17,800 lb. Thus the thrust improvement would amount to 80 percent in that particular soil. Thrust gain may be computed by means of this method in any soil, provided that soil data contained in equations [1] and [2] are given.

The redesign of tractor components and attachments in order to materialize these ideas would be an enormous project. The author feels encouraged, however, to present these ideas at the present time because articulated wheeled tractors were discussed at the ASAE meeting in Chicago in December, 1957, and other promising features of this configuration were mentioned.

The spaced-link track is a reality, experimentally tested, and so is the steering by articulation. It would appear, therefore, that the time may be ripe for the next step in a search for better performance.

It must be stressed, however, that notwithstanding what the value of an articulated spaced-link tractor may be, any further research must be based on physical measurements of soil such as, or similar to, those mentioned in this paper.

References

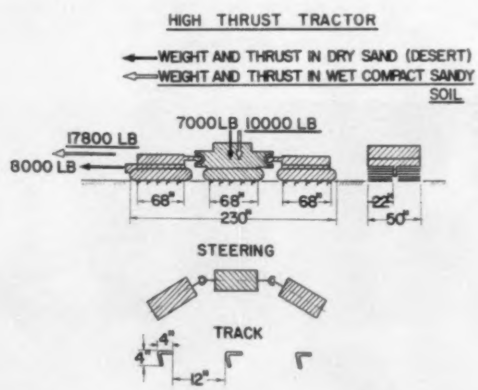
1 Bekker, M. G. An introduction to research on vehicle mobility. Canadian Dept. of Nat'l. Defense, Ottawa, 1948. Second Printing: Aberdeen Proving Ground, Md., 1953. Third Printing: Land Locomotion Res. Br., OTAC, Detroit, Mich, 1958.

2 Bekker, M. G. Latest developments in off-the-road locomotion. Franklin Institute Journal No. 5, May 1957.

3 Terzaghi, K. Theoretical soil mechanics. J. Wiley and Sons, New York, 1944.

4 U.S. Patents Nos. 2,708,608; 2,685,481; 2,726,904; 2,738,237.

5 Bekker, M. G. Theory of land locomotion—the mechanics of vehicle mobility. 495 pp, University of Michigan Press, Ann Arbor, Mich., 1957.



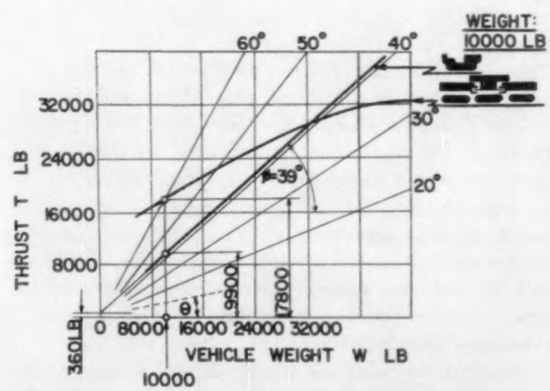


Fig. 9 *(Left)* A three-unit tractor offers thrust improvement over single conventional model • Fig. 10 *(Right)* Performance of three-unit tractor is compared with conventional tractor

Energy Requirements for Cutting Forage

W. J. Chancellor
Assoc. Member ASAE

Actual cutting of forage crops requires only small portion of energy supplied to most hay-cutting devices

MANY investigations have been made of the power requirements of machines that cut or chop forage crops. The power used for cutting alone is usually proportioned from total power by one of various analysis procedures. This is a report of laboratory experiments designed to determine the nature of the cutting process directly, together with the effects of some of its more common variables.

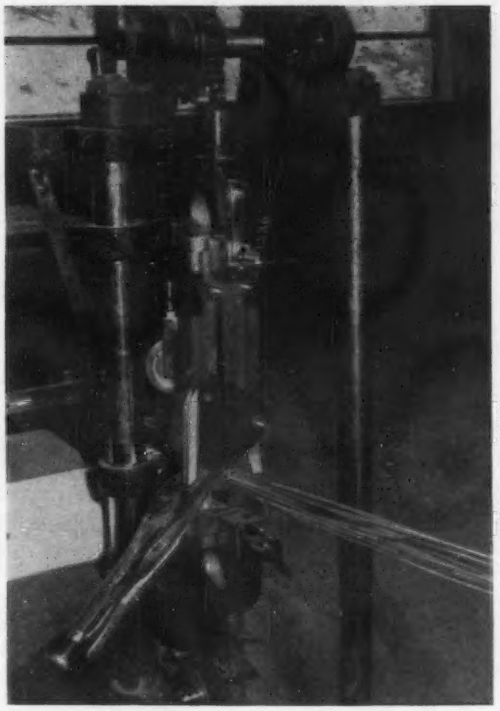
Fig. 1 shows the apparatus used to measure (and continuously record) blade forces and movement at a rate of 1 in. per sec. This procedure permitted evaluation of energy consumed. The cross-sectional area of the stems being cut — controlled at fixed values — was measured by determining the weight of dry matter contained per unit of length of the bundle of stems.

Blade velocities similar to those found in reciprocating mowers (70 to 200 in. per sec) were obtained with the equipment shown in Fig. 2. An accelerometer pickup was attached to the stationary edge assembly. Maximum force values were computed from maximum accelerations. Assumption of a constant relative velocity between the cutting edges permitted energy-consumption values to be calculated from the results obtained by electrical integration of acceleration with respect to time.

Paper presented at 51st Annual Meeting of the American Society of Agricultural Engineers, Santa Barbara, Calif., June 1958, on a program arranged by the Power and Machinery Division. Work is based on Ph.D. thesis at Cornell University, Ithaca, N. Y.

The author — W. J. CHANCELLOR — is assistant agricultural engineer, agricultural engineering department, University of California, Davis.

Acknowledgment: The author is grateful to professor C. W. Terry of Cornell University for his valuable advice and assistance in conducting this study.



Other apparatus was used for cutting single stems upon impact with a blade moving at velocities similar to those of commercial impact-type cutters (140 to 280 fps). The only quantity measured was the deflection of the stem at the point of blade contact, from which the portion of energy transmitted to the stem was computed.

Following are interpretations of the results of several thousand trials with this and similar equipment. Each of the curves plotted represents an average of numerous groups of trials.

Nature of the Cutting Process

Fig. 3 is a representative trace of blade forces versus blade movement. In area A, the pile of stems is being compressed without cutting taking place. In area B, compression and adjustment to pressure are continuing after the failure of one or two stems immediately adjacent to the blade. In area C, stem failure is taking place regularly as the blade progresses.

Observations at a cutting speed of 1 in. per min indicate that during compression each stem is flattened into two

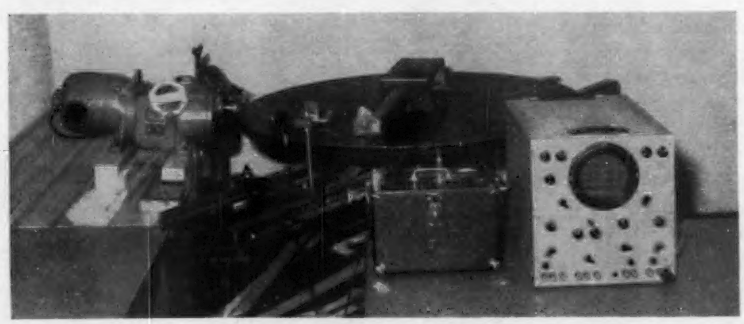


Fig. 1 *(Top)* Apparatus for measuring cutting forces and energies at a speed of 1 in. per sec

Fig. 2 *(Left)* Equipment used for measuring cutting forces at blade speeds up to 200 in. per sec

. . . Energy Requirements

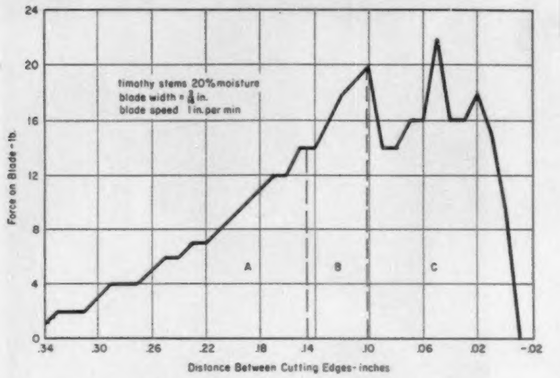


Fig. 3 Force-displacement diagram for a mower blade cutting a cross-sectional area in which 0.00108 lb of dry matter are contained per lineal inch of the bundle of stems

sheets of fibers. These fiber sheets fail separately, causing the jagged appearance of the trace in area C. This system of failure is similar to that found with single stems(1)*.

It is believed that the fiber sheet is stressed *(a)* by bending around the blade edge and *(b)* by direct compression from the blade. These stresses are thought to combine to produce a series of minute tensile failures on a plane of maximum shear stress inclined about 45 deg from the stem axis. This cutting process, then, is different from the shearing process that occurs in a piece of metal with the same mechanism.

Effect of Variables

Units of Measurement. Energy consumption is expressed in terms of the number of horsepower-hours required to chop to ½-in. lengths, an amount of material containing 1 ton of dry matter. Values in these units can be directly applied to a forage harvester if they are first adjusted for length of cut relative to ½ in. For application to a mower the length of cut can be assumed to be equal to the height of the crop.

For all cases except Fig. 8, maximum forces are given in pounds per inch of blade width.

Blade Sharpness. Trials were conducted with blades that had been dulled a fixed amount by grinding. The thickness of the edge or face resting against the stems is specified in Fig. 4. It is shown here that force and energy requirements both increase with blade dullness, but only slightly until a definite degree of dullness (edge thickness of about 0.0035 in.) is reached. It is believed that the critical value of edge thickness increases as the coarseness of the stem increases. Also shown in Fig. 4 are lines indicating force values at which an edge of specified thickness would fail from compressive stresses at levels of 60,000 and 100,000 psi. This indicates that the edge of an extremely sharp blade will be rapidly dulled to a given thickness, but that the increased forces resulting from this dulling are incapable of producing much further immediate dulling.

Blade Bevel Angle. Fig. 5 illustrates the results obtained with blades of various bevel angles. Again it can be noticed that force and energy values increase only after the

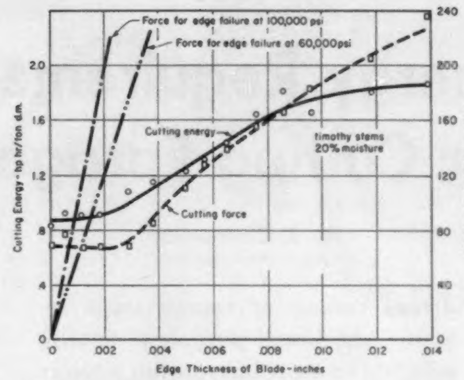


Fig. 4 The effect of dullness on cutting force and energy requirements. The lines on the left show the force required to cause edge failure at any given edge thickness

angle exceeds 30 deg. This is similar to the results of German researchers who found in a 15-hr test that an angle of 24 deg was the most efficient and that small bevel angles resulted in rapid wear and dulling(2).

Aggregate Thickness of Material Between Edges. If the blades are suitably beveled and sharpened, the most significant mechanical factor is the aggregate thickness of the material being cut. The greater the aggregate thickness, the greater will be the energy and maximum force values required for cutting. Fig. 6 shows this to be true with a full range of moisture contents. The aggregate thickness factor can as much as double the energy requirements and triple the force values.

The aggregate thickness of material in Figs. 6 and 7 is given in units of pounds of dry matter per square inch of supporting surface. If the stems are imagined lying on a table, the aggregate thickness of the material would be measured by the weight of dry matter lying over 1 sq in. of table surface. Fig. 7 shows the effect of the aggregate thickness to be similar with the three plant species tested. It is believed that, with greater aggregate thickness of materials, a greater force is required to compress the pile of stems to a firmness that will permit continued cutting. The greater forces needed before and during cutting result in a greater energy consumption.

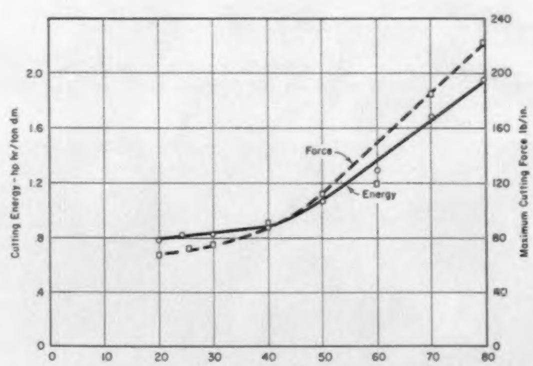


Fig. 5 Effect of bevel angle on cutting force and energy requirements

*Numbers in parentheses refer to the appended references.

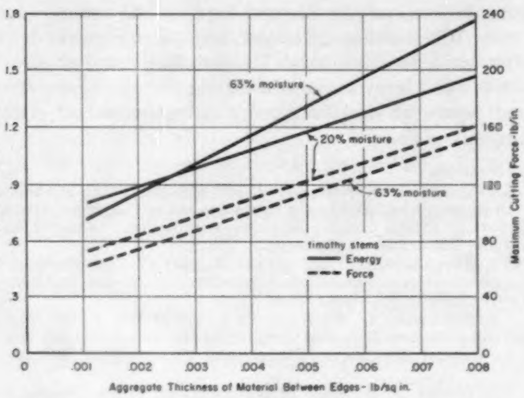


Fig. 6 Effect of aggregate material thickness and moisture content on cutting force and energy requirements

Edge Types. In all cases, forces and energies were greater for blades serrated on the under side than for smooth-edged blades (Fig. 8). This is attributed to the increased thickness of the zone over which an under-serrated blade tends to apply pressure, *i.e.,* the edge is not all in one cutting plane.

As opposed to a square stationary edge, a sharpened stationary edge reduced maximum forces slightly. When used with an under-serrated blade it reduced cutting energy.

Blade Velocity. The values in Fig. 8 were obtained at speeds ranging from 69 to 204 in. per sec. Throughout this range no significant changes in force or energy values due to speed were noticed. The energy values at these speeds were of the same magnitude as energy values obtained at a speed of 1 in. per sec when all other factors were the same.

When cutting by impact it was assumed that the energy consumed in stem failure alone was similar to that measured at lower speeds. The additional energy transferred from the blade to the stem during impact was computed from the measured stalk deflection at the point of blade contact. This deflection was not affected much by variation of blade speed within the range of 140 to 280 fps. It was approximately 1 in. for a mature timothy stem supported 4 in. from the point of blade contact.

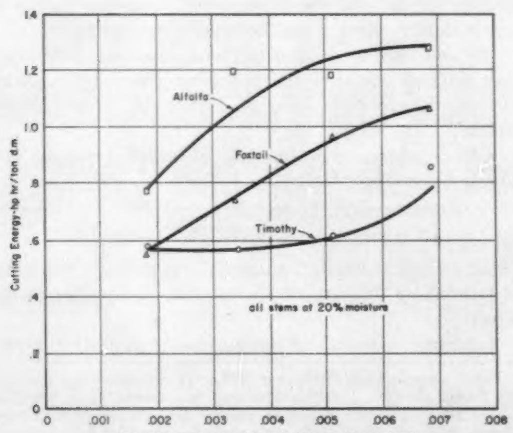


Fig. 7 Effect of plant species and aggregate material thickness on cutting energy requirements

The most significant factor affecting this deflection was the size of the individual stem. The average transferred energies were 0.383 and 0.083 hp-hr per ton of dry matter for heavy and light stems, respectively. The large difference between these values can be more easily understood when it is realized that the heavy stem, because of its greater dimension and requirement for a higher cutting force, is in contact with the blade longer and acted upon with a greater force during contact. Thus the cutting force is applied at higher stem velocities, which results in greater energy transfer. If a larger stem or group of stems were encountered by the blade, the amount of energy transfer might increase to the point where cutting would become incomplete.

Photographs taken with a high-speed flash apparatus showed that, when cutting by impact, the stem becomes completely severed before any noticeable amount of deflection occurs. The deflection that does take place occurs after the passage of the blade.

Clearance Between Edges. The amount of clearance possible without inefficient cutting is believed to depend on the coarseness of the stems: the coarser the stem, the more clearance is permissible. Fig. 8 shows that, with mature timothy stems, up to 0.025 in. can be tolerated if a smooth-edged blade is used. An under-serrated blade will have an effective clearance greater than the measured value. Fig. 8 shows that, with an under-serrated blade, energy consumption has begun to increase at a clearance of 0.025 in.

Angle Between Edges. Results show that maximum forces decrease as the angle between the edges increases, and that energy requirements are minimum at angles between 0 and 20 deg.

Moisture Content. Fig. 6 illustrates the higher energy requirements and lower maximum forces at higher moisture contents. However, the highest force values occurred at 35 percent moisture, when the stems could be described as "tough".

Plant Species. The energy requirements for dry stems of three different plants are shown in Fig. 7. In all cases the values for alfalfa were highest. This is attributed to the increased size and firmness of the alfalfa stem, which necessitated greater blade travel at higher force levels.

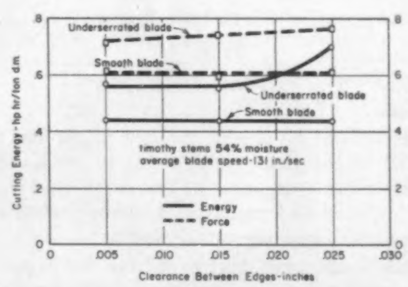


Fig. 8 Effect of clearance and blade type on cutting force and energy requirements. The cross-sectional area is such that 0.00054 lb of dry matter is contained per inch of length of the bundle of stems

Application of Experimental Values

Example I — Forage Harvester:
Material — standing timothy — 75 percent moisture.
Length of cut — 1 in.
Number of cuts per minute — 3200.
Rate of harvesting — 30 tons per hour.
Throat width — 14 in.
Pounds of dry matter per minute=

$$\frac{30 \text{ ton/hr} \times 2000 \text{ lb/ton} \times 25 \text{ percent dry matter}}{60 \text{ min/hr}}$$
$$=250 \text{ lb/min}$$

Aggregate thickness of material=

$$\frac{250 \text{ lb/min}}{3200 \text{ cut/min} \times 1 \text{ in./cut} \times 14\text{-in. throat}}$$
$$=0.00558 \text{ lb/sq in.}$$

From Fig. 6, rate of energy consumption=1.3 hp-hr per ton of dry matter chopped to ½-in. length. Since length of cut is 1 in., energy rate is 0.65 hp-hr per ton of dry matter.

$$0.65 \text{ hp-hr/ton} \times 30 \text{ ton/hr} \times 25 \text{ percent dry matter}$$
$$=4.88 \text{ hp}$$

Example II — Mower:
Material — standing timothy.
Average height of crop — 24 in.
Expected yield — 2 tons of 20 percent moisture hay per acre.
Width of swath — 7 ft.
Rate of travel — 7 mph.
Blade type — under-serrated.
Tons of dry matter per hour=

$$\frac{7 \text{ mph} \times 5280 \text{ ft/mi} \times 7 \text{ ft} \times 2 \text{ ton/A} \times 80 \text{ percent dry matter}}{43560 \text{ sq ft/A}}$$
$$=9.53 \text{ ton/hr}$$

From Fig. 8, energy consumption is 0.56 hp-hr per ton of dry matter cut to ½-in. lengths. Because the cross-sectional area of the base of the stalks cut by a mower is approximately twice the average area of the stalk, this value is doubled to 1.12 hp-hr per ton, for application to a mower. Since this value is based on a ½-in. length of cut, and only one cut is made in each 24-in. stalk, the power requirement is computed by:

$$\frac{9.53 \text{ ton/hr} \times 1.12 \text{ hp-hr/ton} \times \tfrac{1}{2} \text{ in.}}{24 \text{ in.}}$$
$$=0.22 \text{ hp}$$

Conclusions

1 The amount of energy required to cut the forage crops tested ranged from 0.4 to 2.4 hp-hr per ton of dry matter chopped to ½-in. lengths. This is less than has been generally expected and represents a minor portion of the energy supplied to most hay-cutting devices.

2 Blade forces range downward from 300 lb per in. of blade edge, with usual values less than 150 lb per in.

3 Other than blade bevel and sharpness, the most important factor affecting cutting forces and energies is aggregate thickness of the material between the cutting edges.

4 When cutting by impact, single stems are cut before they can deflect noticeably. The deflection that does occur is a result of energy transferred during cutting. Larger stems and groups of stems will result in the transfer of greater amounts of energy.

References

1 Fisher, D. A., Kolega, J. J. and Wheeler, W. C. An evaluation of energy required to cut forage grasses and legumes. Progress Report 17 (Storrs Connecticut Experiment Station, College of Agriculture, University of Connecticut, 1957).

2 Fisher-Schlemm, W. S. and Eggert, O. Der einfluss des hackselmesser-watenwinkels auf schnitthaltigkeit und kraftbedarf. Landtechnische Forschung, Heft 4, 1955.

3 Barrington, G. P., Berge, O. I. and Duffee, F. W. Forage harvester studies. Report of Project 406-Hay Harvesting Machinery (Agricultural Engineering Department, University of Wisconsin, 1954).

4 Blevins, F. Z. Some of the component power requirements of field type forage harvesters. Unpublished Thesis. Purdue University, 1954.

5 Chancellor, W. J. Basic concepts of cutting hay. Unpublished Thesis. Cornell University, 1957.

6. Schulze, K. H. Uber den schneidvorgang an Grashalmen. Grundlagen Der Landtechnik, Heft 5, February 1953.

Discussion on "Energy Requirements for Cutting Forage"

C. B. Richey
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MR. CHANCELLOR is to be commended for securing basic information on the fundamental process of cutting forage. Cutting power is particularly important in field forage harvesters.

The power required by a forage harvester cutter head is influenced by the following factors:

Air and bearing friction.
Kinetic energy imparted to the material by knives and paddles.
Frictional resistance of the material as it passes through the housing.
Cutting energy, depending primarily on length of cut and shearing resistance of the material.

In attempting to increase the efficiency of a forage harvester it is necessary to be able to determine the power required for each of the above items. Then the effects of various design changes can be readily evaluated.

Air and bearing friction can be approximated by measuring no-load power at the operating speed, although air delivery is probably reduced somewhat when cutting material.

Kinetic energy is a function of material weight and velocity and can be calculated as follows:

Kinetic energy, hp-hr/ton=
$(\text{peripheral velocity, fps})^2/63{,}680$

About 100 fps is usually considered the practical minimum for satisfactory delivery of all materials to the rear of the wagon.

Frictional resistance of the material is difficult to evalu-

Paper prepared for discussion of Energy Requirements for Cutting Forage by W. J. Chancellor and was presented at the 51st Annual Meeting of the American Society of Agricultural Engineers at Santa Barbara, June 1958, on a program arranged by the Power and Machinery Division.

The author — C. B. Richey — is chief research engineer, Tractor and Implement Division, Ford Motor Co.

ate. Calculations based on angle of wiping contact, centrifugal force, weight of material and coefficient of friction have been made by Barrington, Berge and Duffee and also by Blevins (see references, Chancellor article), but the exact path of the cut forage through the machine may vary from that assumed for the calculations.

If the *cutting energy* required by the material is known, it can be added to the kinetic energy and the no-load power. Then the difference between the sum of these and the total cutterhead power represents the power expended to overcome frictional resistance of the cut material passing through the housing. This latter item is entirely parasitic and offers the greatest opportunity for reducing forage harvester power requirements. Evaluation of cutting energy has been the missing link in forage harvester power analysis and Mr. Chancellor's paper is of particular interest from this standpoint.

The problem of evaluating cutting energy has, in our work, been approached from the standpoint of comparing power requirements at different lengths of cut. This approach was made after the field tests had been made and only a limited number of runs were found suitable for analysis, so the results cannot be taken as conclusive, although they are not greatly different from those indicated by Mr. Chancellor.

It is logical to assume that cutting energy per ton is inversely proportional to the theoretical length of cut. If power comparisons are available for the same material cut at two different lengths but at the same knife speed and the same rate, it is possible to estimate cutting energy from the difference in horsepower-hours per ton by the use of the following formula:

Cutting energy to cut into 1-in. lengths, hp-hr per ton

$$= \frac{\text{(difference in cutter head energy between two runs, hp-hr per ton)}}{\text{(additional cuts per inch in shorter-cut run)}}$$

$$= \frac{\text{(cutter head hp-hr per ton at length A} - \text{cutter head hp-hr per ton at length B)}}{\text{(cuts per inch at length A} - \text{cuts per inch at length B)}}$$

For example, if green alfalfa required 1.25 hp-hr per ton at ½-in. cut and 1.0 hp-hr per ton at 1-in. cut

$$\text{Cutting energy} = (1.25 - 1.0)/(2 - 1)$$
$$= 0.25 \text{ hp-hr per ton per inch}$$

This method of determining cutting energy did not give consistent results with cuts over 1½-in. long, particularly with cutterheads having high friction losses. Apparently the longer pieces caused extra friction where the clearance was close, and in some cases little power was saved by going to the longer cut.

In comparing two runs, it is important that they be run at the same cutterhead speed, since speed is an important factor in power consumption. The change in kinetic energy with speed can be calculated as shown above, and corrected for, but the friction effects of the additional centrifugal force cannot be accurately evaluated.

In Table 1, data for several comparable pairs of runs are shown with the calculated cutting energy, using the above method of analysis. These results indicate that a figure of 0.25 hp-hr per ton for 1-in. theoretical length of cut may be a reasonable assumption for green alfalfa with 72.5 percent moisture. This would give 0.9 hp-hr per ton of dry matter for 1-in. cuts or 1.8 hp-hr per ton dry matter for ½-in. cuts. This is near the upper end of the range indicated in Chancellor's Fig. 6.

In the first pair of Ford flywheel tests, layer thickness was held constant and length of cut changed by dropping from six knives to two knives. In the other tests, length of cut was varied by changing the feed speed, resulting in a thinner layer for the longer cuts. This would tend to penalize the short cut somewhat, increasing the estimate of cutting energy, according to Chancellor's findings. In these tests, the effect of layer thickness does not appear to be important. Knives were reasonably sharp in the Ford tests but sharpness was not measured.

Generally in the Ford tests, the cutter head hp-hr per ton decreased with increasing feed rates except where extra friction was apparently introduced due to overloading the cutterhead housing. This increased efficiency at higher rates would indicate that greater layer thickness did not greatly increase cutting energy requirements.

It is possible that the high speed cutting action of a forage harvester, five or six times the velocity of Mr. Chancellor's highest speed of 204 in. per sec, compresses the hay without allowing it to spring back appreciably between cuts. A four-blade cylinder type cutterhead operating at 1000 rpm makes 67 cuts per second, allowing little time for spring back between cuts and reducing energy consumption needed for recompression at each cut. In Mr. Chancellor's tests of single stroke cutting, the energy required would always include full compression of the material, perhaps accounting for the increase in energy with layer thickness. Thus, layer thickness could be an important factor in mower power but less important in forage harvester power.

TABLE 1. CUTTING ENERGY REQUIRED FOR GREEN ALFALFA, 72.5 PERCENT MOISTURE, CALCULATED FROM COMPARABLE PAIRS OF TESTS OF VARIOUS FORAGE HARVESTERS

Source of data	Type of cutterhead	Theo. length of cut, in.	Knife tip speed, fpm	Rate, tons per hour	Cutter head power, hp	Cutter head energy hp-hr per ton	Feed layer, lb dry matter per sq. in.	Calc. cutting energy, hp-hr per ton for 1-in. cuts
Blevins Thesis, 1954	Cylinder	0.5 1.0	4060 4120	22.6 18.7	19.5 11.7	0.86 0.63	0.0028 0.0011	0.23
		1.0 2.0	4120 4450	18.7 18.0	11.7 9.6	0.63 0.53	0.0011 0.0005	0.20
Ford, unpublished, average 2 runs	Cylinder	0.5 1.0	6240 6250	14.5 16.1	16.1 15.1	1.11 0.94	0.0042 0.0023	0.17
Ford, unpublished	Flywheel	0.5 1.5	5280 5280	13.8 13.2	26.7 21.3	1.94 1.61	0.0063 0.0060	0.25
Ford, unpublished, average 3 runs	Flywheel	0.5 1.0	5410 5230	16.8 27.3	18.4 21.1	1.10 .77	0.0075 0.0063	0.33

Discussion on "Energy Requirements for Cutting Forage"

R. P. Prince, W. C. Wheeler and D. A. Fisher
Assoc. Member ASAE   Member ASAE

THE energy requirement problem in harvesting forage crops was undertaken by the agricultural engineering department of the Storrs Connecticut Agricultural Experiment Station as a contributing project to Regional Research Project NE-13, "The Mechanization of Forage Crops, Harvesting, Processing, Storing and Feeding." A dual approach to the problem is under way. One is to analyze the cutting action and the actual cutting forces of conventional mowing machines. The other approach is to determine the unit cutting (or shearing) energy of the more common forage plants.

Paper prepared for discussion of Energy Requirements for Cutting Forage by W. J. Chancellor and was presented at the 51st Annual Meeting of the American Society of Agricultural Engineers at Santa Barbara, Calif., June 1958, on a program arranged by the Power and Machinery Division.

The authors — Ralph P. Prince, William C. Wheeler, and David A. Fisher — are respectively, assistant professor and professor of agricultural engineering and professor of mechanical engineering, University of Connecticut, Storrs.

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Fig. 1 Aluminum sensing link for mower knife force determination

Fig. 2 Instrumented sensing link in position for force measurements

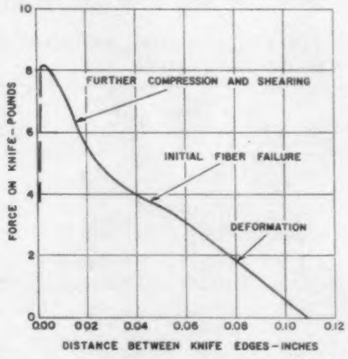

Fig. 3 Cutting pattern for one stalk of alfalfa

Cutting Action

A motion picture of the cutting action of a mower was filmed at the rate of 3000 frames per sec. The mower crank speed was 1000 rpm and the equivalent ground speed was 3⅛ mph. A 4-in. cutting height was maintained throughout. With this combination of ground to crank speed (1.92 in. per stroke) double shear on the stubble occurred. There is some indication that crushing one stalk against another occurs in heavy stands rather than the shearing of stalks against the ledger plate. Under these conditions fiber failure evidently occurs in tension rather than in shear which tend to increase the energy requirement.

Mower Field Tests

Two mower knives were instrumented with SR-4 strain gage sensing links, Figs. 1 and 2. These aluminum links were capable of sensing both tension and compressive loads ranging from 0 to 500 lb. A total load in either direction of knife travel was therefore obtained. Assuming that friction forces did not change from no cutting to cutting, the difference in the force was then a measure of the actual cutting force. This assumption of the friction forces remaining rather constant was apparently in error because a force approximately 10 times the actual force required for cutting, on an individual stalk basis, was recorded.

Our results show numerous ways in which energy transfer may occur besides friction. The bending of the stalks to the ledger plate, the cutting of one stalk against another and the cutting at angles other than 90 deg all combine to influence the forces on the cutterbar knife. It is possible to have a combination of these effects throughout a single stroke.

Individual Stalk Energy Requirement

There were three phases to the analysis of single stalk forage cutting characteristics. First was the determination of stalk deformation, fiber failure and the point where actual shear occurred. Second was to determine the energy required to shear single stalks under known conditions and third was to determine the effect of dullness of knife edge on the energy requirement.

To make some determination of the cutting process a

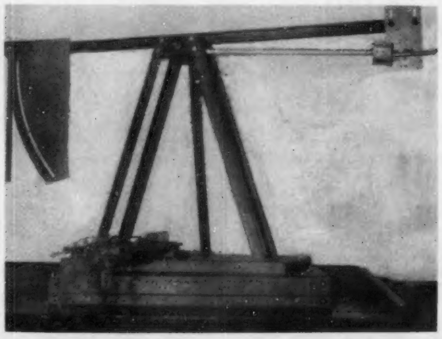

Fig. 4 The dynamic shear testing machine

TABLE 1. ENERGY REQUIRED TO SHEAR SINGLE STALKS OF TYPICAL FORAGE PLANTS
(Knife Velocity — 113 Inches per second.)

GRASS	ENERGY REQUIRED E = ENERGY — INCH POUNDS D = DIAMETER — INCHES	DIAMETER RANGE-INCHES	AGE-DAYS	DEVIATION FROM EQUATION INCH POUNDS	AVERAGE MOISTURE CONTENT-%
Alfalfa	$E = 0.0895 - 2.56D + 24.7D^2$	0.06 — 0.14	28	±0.02	80
Alfalfa	$E = -0.26 + 2.58D + 11.5D^2$	0.10 — 0.30	35 — 37	±0.15	78
Alfalfa	$E = 0.00211 - 0.633D + 26.6D^2$	0.08 — 0.13	55	±0.04	73
Alfalfa (Second Cut)	$E = -0.0412 + 0.316D + 21.6D^2$	0.06 — 0.14	35 — 42	±0.04	72
Blue Grass	$E = 0.0066 + 0.372D + 6.53D^2$	0.02 — 0.06	35 — 40	±0.01	70
Ladino Clover	$E = 0.0366 - 0.560D + 6.79D^2$	0.04 — 0.14	40 — 42	±0.01	87
Orchard Grass	$E = -0.0379 + 1.24D + 5.64D^2$	0.06 — 0.11	30	±0.02	74
Orchard Grass	$E = 0.215 - 3.65D + 33.3D^2$	0.09 — 0.13	45	±0.04	68
Reed Canary	$E = 0.106 - 0.210D + 20.4D^2$	0.15 — 0.27	35	±0.15	76
Timothy	$E = -0.0522 + 1.65D + 8.96D^2$	0.06 — 0.12	35 — 40	±0.03	78

knife was made to move slowly through the stalk and past a stationary knife. By knowing both the load and the distance the knife moved, the curve shown in Fig. 3 was obtained. The area under the curve is an indication of the total energy required for the cutting process. The initial deformation period accounted for about 25 percent of the total energy process. Evidently the force pattern changes with knife speed due to the time rate of stalk deformation causing some reduction in energy requirement.

A pendulum (Fig. 4) was used to determine the total energy required to shear individual forage stalks. The velocity at impact was 113 in. per sec. The knives were ground to an 18-deg included angle. These design features were in keeping with the design of some conventional mowers.

Samples of the more common forages were tested during 1956. Plants were first cut in the field at ground level. The cut in the laboratory corresponded to standard mower field practice.

A minimum of 50 stalks of each species constituted a test sample. Energy values were plotted against the stalk diameter at the point of cut. A curve was then fitted to the data using the least square method. The equations shown in Table 1 are valid only in the diameter range indicated. It is interesting to note that 85 percent of the data points fell within the deviation range indicated in the table.

Figs. 5 and 6 show the energy required to cut individual forage stalks. In general, the younger and more succulent plants require less energy than the more mature plants. For example, alfalfa at 55 days required about twice the energy to cut as alfalfa at 28 days for the same stalk diameter while the moisture content dropped only 7 percent. Evidently moisture content affects the energy requirement only slightly. This increase in energy requirement was more likely caused by changes in plant cell structure and physical changes within the plant which are affected by soil and weather conditions.

Tests on alfalfa were made to determine the variations in fiber strength along the stalk from the base and upward. Cuts were made at 1-in. intervals. The ratio of the energy at any point to the energy required at a distance of 3 in. from the base is shown in Fig. 7. From the base to about 3 in. above the base the energy value remained rather constant. At a distance of 10 in. from the base the energy value had decreased by one-half. This decrease in energy value may be attributed to the corresponding decrease in stalk diameter.

To bring out the effect of fiber strength, the energy required at each point was divided by the corresponding cross-sectional area. The curve of energy per square inch indicates that the energy requirement decreases more rapidly than the area. This effect may then be considered a measure of the decrease in toughness of the fiber along the length of the stem.

Three sets of knives were made up to simulate dulled knife and ledger plate condition of conventional mowers. While the mowing machine knife is seldom dulled uni-

(Continued on page 652)

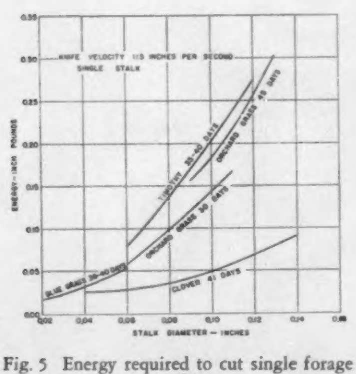

Fig. 5 Energy required to cut single forage stalks

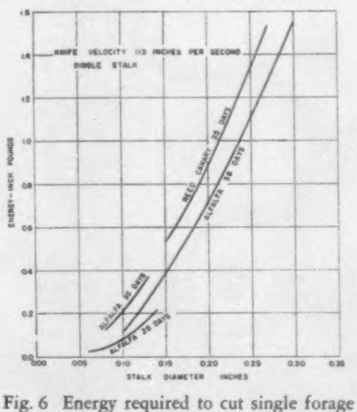

Fig. 6 Energy required to cut single forage stalks

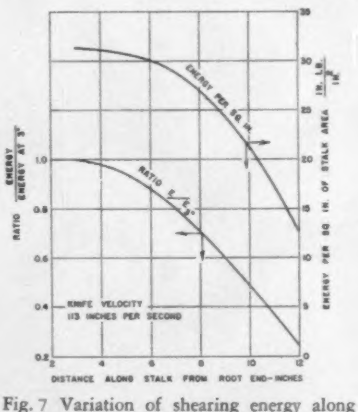

Fig. 7 Variation of shearing energy along the length of a single stalk of alfalfa

Measuring Light Transmittance Properties of Agricultural Commodities

K. H. Norris
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Instrumentation makes possible measurements of maturity, internal color and internal defects in apples, peaches, and most other fruits and vegetables — at speeds sufficient to permit automatic sorting

MUCH effort has been devoted to techniques for evaluating surface appearance of agricultural commodities. This effort has resulted in instruments to measure surface color and automatic machines to sort agricultural commodities on the basis of surface color. However, these developments do not permit evaluation of the interior characteristics of a sample. In most cases the interior characteristics are far more important than that of the exterior surface.

Brant, Norris and Chin in 1953 (4)* described a technique for use in detecting blood in intact white-shell eggs. They made use of a Beckman DU Spectrophotometer†, which had been modified by the addition of a more powerful light source, and the substitution of a multiplier phototube and a sensitive recorder for the normal measuring circuit. With this instrumentation they were able to measure the spectral transmittance curves for intact eggs for the wavelength range from 400 to 700 mμ. The success of this effort inspired the development of instrumentation to measure the spectral transmittance properties of a wide range of agricultural commodities.

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*Numbers in parentheses refer to the appended references.

†The mention of specific instruments or trade names is made for purpose of identification and does not imply any endorsement by the U. S. Government.

Acknowledgment: The author wishes to acknowledge the assistance of J. D. Rowan, G. S. Birth and C. K. Powell in the design and construction of the instrumentation.

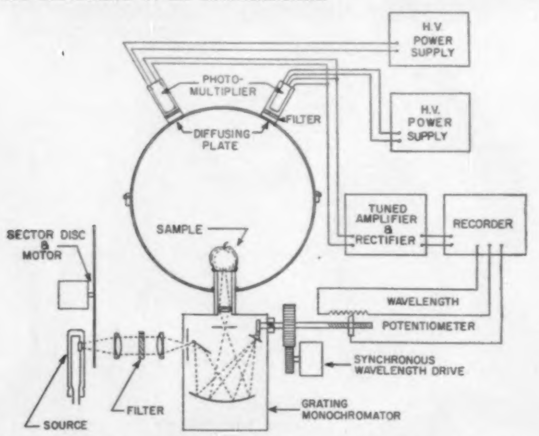

Fig. 1 Block diagram of instrument for recording the spectral transmittance properties of intact fruits and vegetables

Design Consideration

The main problem in attempting to measure the spectral transmittance properties of an object such as an apple or a tomato is the problem of collecting sufficient energy from the transmitted signal. Such samples contain a large quantity of scattering material. The light is not transmitted in a straight line through the object, but rather is reflected and scattered many times. As a result the light emerges from all parts of the sample.

To collect the maximum amount of light under such conditions the phototube would have to be in the form of a sphere completely surrounding the sample. The nearest approach to this condition can be attained by enclosing the sample in a light-integrating sphere with a phototube viewing a small port in the sphere to measure the brightness of the sphere surface. Nearly all of the transmitted light can be collected by this arrangement regardless of where it emerges from the sample.

The interior surface of an integrating sphere must be coated with a material having a high diffuse reflectance over the spectral region to be covered. High-quality flat white paints are suitable for wavelengths from 500 to 1000 mμ, but their reflectivity falls off rapidly for shorter wavelengths. For most applications with agricultural commodities a titanium dioxide paint has proven adequate because the transmittance of such materials as peaches, apples, tomatoes, etc. is so low for wavelengths below 500 mμ that the transmitted energy cannot be measured. If measurements below 500 mμ are required, the interior surface of the sphere may be smoked with magnesium oxide, which has a high reflectivity down to 250 mμ. The magnesium oxide is a fairly fragile surface, but with careful handling the surface can be used for several months, and it is not too difficult to resmoke the sphere.

To obtain maximum signal response the sphere size, the sample, and the phototube port should bear a certain relationship to each other. The mathematical analysis of this relationship is too complex for solution without the use of a high-speed computer. Since this relationship could not be derived, the size of the sphere and phototube port were selected by a reasonable choice. End-window multiplier phototubes having a flat cathode 1½ in. in diameter were chosen to measure the light so the phototube port was also made 1½ in. in diameter. A 12-in.-diameter sphere was chosen as the proper size for use with samples as large as 3 in. in diameter. A 24-in.-diameter sphere was selected for larger samples.

For maximum signal response the sphere should be as small as possible, but it must be large in comparison with

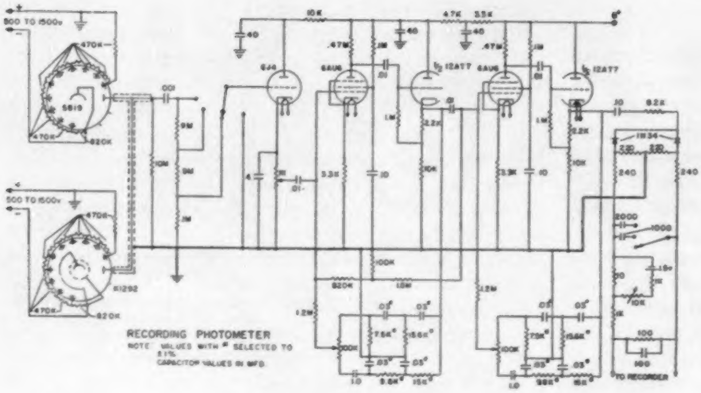

Fig. 2 Schematic of recording photometer

the sample to prevent reflectivity effects from the surface of the sample. From the limited experience to date it appears that the best choice would be a sphere diameter about five times the maximum dimension of the sample. The phototube port should be about one-tenth the diameter of the sphere.

Even though an integrating sphere is used to collect the light transmitted by an apple, the amount of energy available for measurement is very low unless a very powerful light source or a wide spectral bandwidth is used to illuminate the sample. The transmittance measurement should be made with a spectral bandwidth narrow enough to define the absorption bands present in agricultural commodities. This requires a bandwidth of 5 mμ or less in many cases. It is possible to attain this requirement without using an unreasonably large energy source by using multiplier phototubes and a high-gain amplifier. To attain the maximum signal-to-noise ratio a narrow-bandwidth tuned amplifier and a chopped light beam are essential. This system provides a much greater zero stability and greatly reduces the noise fluctuations generated in the phototube.

Construction

Fig. 1 shows a block diagram of the instrument as constructed in our laboratory. The light source is a ribbon-filament, 100-watt tungsten lamp. The source beam is chopped by a sector disk rotating at 1700 rpm. This disk, containing 12 uniformly spaced circular openings, produces a chopped beam at 340 cycles per second. A lens system images the lamp filament on the entrance slit of the monochromator. Provision is included for insertion of filters to reduce stray light when necessary.

A Bausch and Lomb grating monochromator is used to disperse the light beam. A synchronous speed motor and a quick-change gear train were added to drive the wavelength drum. This arrangement provides wavelength drive speeds of 37.5, 75, 150, 300, 600, 900, and 1200 mμ per minute. The monochromator is mounted underneath the integrating sphere with the exit beam vertical. The 24-in. diameter sphere is split in the center with the upper hemisphere movable for insertion of the sample. For the 12-in.-diameter sphere a 6-in. sector was cut from the bottom. This sector is mounted rigidly above the monochromator. The larger portion of the sphere is supported by a drill press frame. The sphere is raised vertically to insert the sample and then lowered into position for the measurement. In the lowered position the two parts of the sphere are sealed by a light-tight gasket to exclude external light. The interior of the sphere is painted with two coats of a high-quality flat white paint and then smoked with magnesium oxide.

Two end-window multiplier phototubes are mounted on the top of the sphere with 1½-in. diameter ports for each tube. Two phototubes are used to obtain as wide a spectral response as possible. A DuMont K1292 with an S-1 photocathode surface and an RCA 5819 with an S-11 photocathode provide a useful spectral response from 350 mμ to 1100 mμ. The output signals from these two phototubes are added by connecting the anodes together. Two separate high-voltage power supplies provide dynode voltages to the phototubes. Each power supply is highly regulated and adjustable from 500 to 1500 volts. The use of independent power supplies permits convenient adjustment of the sensitivity of each phototube.

A narrow-bandwidth tuned amplifier was constructed for amplifying the anode signal. Fig. 2 shows a schematic of this amplifier. The first stage is a cathode follower incorporating a step attenuator and a continuously variable attenuator. This is followed by two tuned amplifier sections using one stage of amplification and a cathode follower with a feedback circuit including a ladder type R-C rejection network. The constants of the feedback networks are chosen to provide a frequency of 340 cycles per second as described by Clothier and Hawes(5). The potentiometers used in these networks permit a slight adjustment of the tuned frequency to match that of the light-beam chopper.

This amplifier exhibited a low frequency oscillation under some conditions. It was necessary to add a parallel resistive feedback path to the first amplifier section to correct this condition. This amplifier has a maximum gain of 20,000 with an input noise level of less than 1 μv. With an input impedance of 10 megohms it is thus possible to measure anode currents as low as 10^{-13} amp.

The output from the amplifier is rectified and filtered for indicating and recording by an electronic recorder. Two types of recorders have been used: an adjustable span (1 to 20 mv) strip-chart recorder and an X-Y recorder. The response time of the system is 1 sec for full scale travel at the fastest speed. It can be increased to 5 sec for reducing noise fluctuations for low-speed recording.

Since the wavelength drive of the monochromator gives a linear wavelength change with time the wavelength

calibration of the strip chart is quite simple. A microswitch is mounted on the wavelength drum to activate a marker pen on the recorder for each 100 mμ. A quick-change gear train is also used on the strip chart drive, so any desired spectral interval can be recorded on a convenient length of paper. The signal for the wavelength drive for the X-Y recorder is obtained from a 10-turn potentiometer coupled to the wavelength drum of the monochromator. The adjustable zero and sensitivity of this recorder permits a wide range of wavelength spans to be recorded.

The use of two phototubes provides a wide spectral response, but, of course, this response varies with wavelength. Therefore, the recorded transmittance curve for a sample is not a true transmittance curve. To obtain the true curve a correction must be made for the system response. For most applications it is not necessary to have a true curve, because the curve for one sample can be compared with the curve for another sample to determine the significant differences. However, for those cases where a true transmittance curve is desired a method has been developed to automatically correct for the system response. To accomplish this the system response with no sample is recorded on the X-Y recorder using conducting ink. Using the curve-follower attachment for this recorder, this response curve can then be played back at will. A transmitting slidewire is included in the X-Y recorder. By substituting this slidewire for the span-adjusting potentiometer of the strip-chart recorder and by maintaining the wavelength synchronization between the recorders and the monochromator, the system response can be cancelled out and a flat response obtained.

Performance

Fig. 3 shows typical transmittance curves as recorded on the X-Y recorder. These are direct tracings inked by the recorder on drawing paper. For these curves the 5819 was operated at 600 v and the K1292 at 900 v. The slit width of 0.5 mm gives a bandwidth of 3.3 mμ. Curve (A) is for a mature Jonathan apple, curve (B) is for a less mature apple, and curve (C) is the system response. For each curve the sensitivity of the amplifier was adjusted to give a full scale reading at the wavelength of maximum energy. Therefore, no importance should be given to the transmittance value at any one wavelength. However, the curves may be compared with each other or one wavelength may be compared with another on a given curve. Apple A shows evidence of absorption bands at 840 mμ, 760mμ, 675 mμ, 630 mμ, and a general absorption of all wavelengths below 550 mμ. Apple B shows absorption bands at 840 mμ, 760 mμ, 650 to 690 mμ, 630 mμ, 560 mμ, and a general absorption of all wavelengths below 510 mμ. The absorption band at 760 mμ corresponds to a water band and that at 675 mμ to chlorophyll. The other absorption bands have not been identified.

The curve for apple B shows a much higher absorption than apple A in the chlorophyll region, indicating that its chlorophyll content is probably much greater. Also, the curve for apple B shows less absorption than apple A in the 550 mμ region, indicating that the pigment causing this absorption must be lower in apple B. From an external appearance apple A appeared to be more mature than apple B — it is to be expected that the more mature apple would

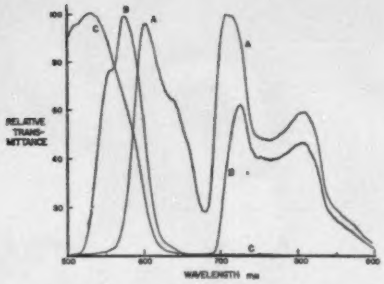

Fig. 3 Relative transmittance curves for two apples. Curve A is for a mature apple. Curve B is for a less mature apple. Curve C is the system response with no sample

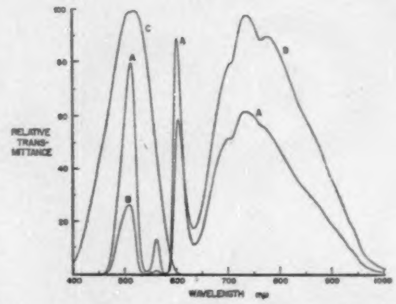

Fig. 4 Relative transmittance curves for two samples of ground beef. Curve A is for a lean ground beef sample. Curve B is for a fat ground beef sample. Curve C is the system response with no sample

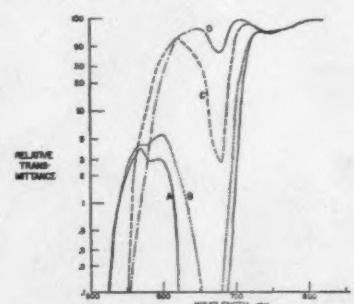

Fig. 5 Transmittance curves for peaches of different maturity. Curve A is for a green peach. Curve B is for a peach of intermediate maturity. Curve C is for a peach that is near full maturity. Curve D is for a fully mature peach

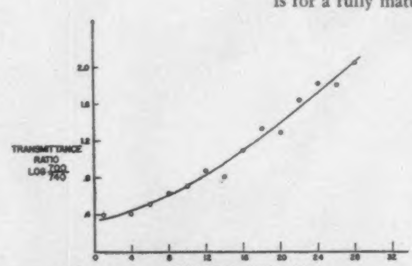

Fig. 6 Relationship between transmittance ratio and maturity for peaches. Each point represents the average of six peaches picked from different parts of the same tree for each picking time

contain less chlorophyll. However, the extreme difference in the transmittance curves is surprising, because the chlorophyll content is known to be quite low in an apple. We have not explored the possibility, but it appears that the transmittance measurement could be useful to indicate maturity of apples.

The transmittance curves for two samples of ground beef are shown in Fig. 4. A 5-gram sample of each was used in a 1⅜-in. diameter cell. This provides a sample thickness of approximately 3/16 in. The curves were recorded with the K1292 operated at 650 v and the 5819 at 600 v with a slit width of 0.5 mm. A Corning No. 9780 filter was placed in front of the 5819 to give the desired spectral response. This response, as shown by curve (C), shows energy in the 400 to 600 mμ region, but the energy at longer wavelengths is too low to be recorded on this scale. This type of system response was necessary because the meat shows such a strong absorption of the short wavelengths. Sample A was a higher quality material referred to as lean ground beef while sample B was labeled merely as ground beef.

From visual appearance it was evident that sample B had a much higher fat content than A although sample A appeared to have a fair amount of fat. The transmittance curves for both samples show strong absorption bands at 640 mμ, 575 mμ, 540 mμ, and at wavelengths below 460 mμ. The 575 and the 540 mμ bands correspond to the absorption bands of blood. The absorption below 450 mμ may be that of the 415 mμ band of blood. The curve for sample B shows a definite absorption band at 760 mμ, corresponding to a water absorption band. The curve for sample A has only a slight hint of an absorption band at this wavelength.

The curves in Fig. 4 show some of the difficulties of interpretation of the recorded results. It appears that sample B has a stronger absorption than A at 540 mμ. This may or may not be true, because they were not recorded at the same sensitivity. It has been found that the best test of the strength of an absorption band is a computation of the ratio of transmittance at the wavelength of peak absorption to that of a nearby wavelength of minimum absorption. Unfortunately this test is not applicable for the 540 mμ absorption because the transmittance at this wavelength is so low that the value is not significant. However, if the test is applied to the 640 mμ absorption it is apparent that sample A has a stronger absorption than B at this wavelength. This test also shows that sample A has less absorption than B at 760 mμ.

The other difficulty in interpretation is that of identifying true absorption bands as distinguished from system response characteristics. The apparent absorption at 710 mμ on both curve A and B is actually a system characteristic. To test this, one must record the system response in the 700 to 750 mμ region at a sensitivity high enough to give accurate results. The system response in this region can be observed from curve (A) in Fig. 7. The drop in response at 710 mμ is apparent.

The curves obtained on these two meat samples indicate that it may be possible to measure fat content of meat by a transmittance measurement. For this purpose the absorption band at 760 mμ should be most useful since it would not be influenced by the pigment content or the color of the meat. Transmittance measurement should also be a very sensitive indicator of the color of meat, using any one or a combination of the 640, 575, or 540 mμ absorption bands. A study to explore these possibilities is being initiated.

Fig. 5 shows the true transmittance curves for four peaches varying in maturity from green to fully ripe. These curves were obtained by transcribing the recorded curves and applying the correction necessary to correct for the system response. The great difference in level of transmittance at different wavelengths requires the use of a logarithmic scale to show the changes which take place as a peach matures. As shown by these curves this change is evidenced in two forms. It can be seen that the wavelength of the short wavelength transmittance peak shifts from 570 mμ to 650 mμ as a peach matures from green to fully ripe. It is also apparent that the transmittance in the chlorophyll region at 675 mμ increases greatly as a peach matures.

The transmittance measurement was tested during the past season as a means of indicating maturity on peaches. Peaches from one tree were picked on successive days beginning August 5 and continuing until September 1. Transmittance measurements were made on these peaches and the ratio of the transmittance at 700 mμ to that at 740 mμ was computed. Fig. 6 shows how the logarithm of this ratio changes with picking date. Each point on this curve represents the average of six peaches to eliminate the variability between peaches picked from different parts of the tree. The normal picking date for these peaches was August 25-30, corresponding to the 20-25 day period on this graph. From these results it is quite apparent that the transmittance measurement can be used to indicate the maturity of peaches as well as to predict well in advance when the peaches should be picked to obtain a given stage of maturity. The transmittance measurement made on these peaches gives essentially a measurement of the chlorophyll content — it has previously been shown that the chlorophyll content is a good index of maturity of peaches(6).

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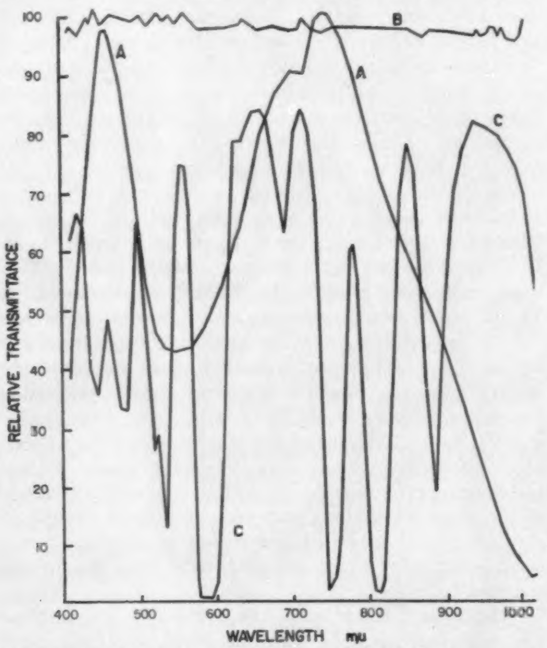

Fig. 7 Spectrophotometer performance with the automatic correction for system response. Curve A is the system response before the correction is applied. Curve B is the recorded response with automatic correction. Curve C is the transmittance curve as recorded for a didymium glass filter

Rainfall Simulator for Runoff Plots

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Donald L. McCune

Engineers develop portable machine to provide simulated high intensity rain storms for test plots as an aid in erosion and runoff studies

A PORTABLE rainfall simulator developed at Purdue University produces artificial storms of approximately the kinetic energy of high intensity natural rainfall. The simulator is used to compare the soil loss, water loss, and infiltration rates of treatments on standard-size rectangular runoff plots.

Simulated storms may be applied to treatments being studied under any condition at any time and as often as desired throughout the year, except on tall crops and during freezing weather.

Factors well suited to tests with the simulator include: soil erodibility, length of slope, percent of slope, past erosion, crop cover at various stages of growth, rotations, fertility level, tillage practices, and residue management.

Soil and water loss evaluations by natural rainfall usually take 10 to 25 years — yet it is often vital to have such information much sooner. The rainfall simulator frequently makes more rapid evaluations possible.

Using Simulator Data

Results from simulator data are intended to be primarily qualitative. Before quantitative erosion rates can be accurately predicted, the limited range of storms produced by the rainfall simulator must be related to natural rain storms. If relationships can be established, natural rainfall data can be used to expand the results obtained with the simulator.

Experiments well suited to the rainfall simulator were made during the summer of 1957. Subsoiling, vertical mulching (13),* and no treatment were studied on plots under corn culture, pasture establishment, and in permanent sod. By measuring the amount and rate of the simulated rain applied and the soil and water lost from these plots, the effects of these treatments on storage capacity, soil loss, water loss, and infiltration were determined. These studies give an indication of the role of subsoiling and vertical mulching as compared to no treatment in conservation farming.

Rainfall simulators are not new. Numerous types and sizes have been developed for various studies since 1930. Notable among studies during the 1930's were simulators used by Lowdermilk(10), Duley and Hays(3), Nichols and Sexton(12), Hendrickson(7), Diseker and Yoder(2), Woodruff, Smith, and Whitt(19), Neal(11) and Borst and Woodburn(1). Little information on the quantitative values of the characteristics of natural rainfall was available at the time of these first studies. The importance of the impact of raindrops was not generally recognized.

In the early 1940's, Laws(8) made a study of raindrop fall velocity as influenced by drop size and distance of fall. This was followed with a study by Laws and Parsons(9) relating raindrop size distribution to rainfall intensity. With these studies as a basis, V. D. Young(15) developed the Type F nozzle which produced a drop size distribution similar to that of high intensity rainfall. Drops from this nozzle are sprayed upward and fall from an average height of only 8 ft. This results in a velocity of fall considerably less than the terminal velocity of most of the drops. Ellison(5) made numerous studies which stressed the importance of the action of raindrops in causing erosion. Ellison and Pomerene(6) developed a rainfall simulator with drops of the same size falling from numerous short lengths of yarn. Ekern(4) made detailed studies of raindrop impact using a simulator which had glass tubes with the tip size controlled.

The Type F nozzle, yarn, and hollow tips of controlled size have been used in numerous more recent simulator studies. All have two distinct disadvantages: *(a)* they require wind shields for even low wind velocities and *(b)*

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The mention of specific trade names is made for the purpose of identification and does not imply endorsement.

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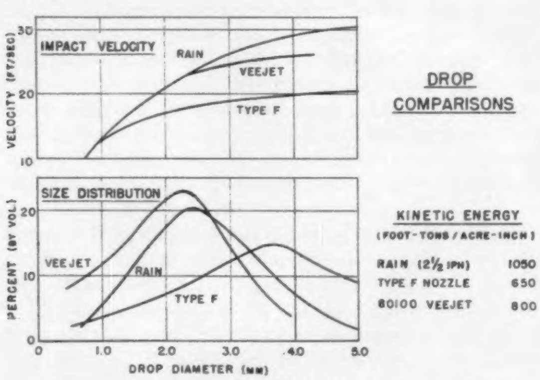


Fig. 1 Physical characteristics of natural raindrops are compared with simulated raindrops

*Numbers in parentheses refer to the appended references.

they require great height of fall to approach terminal drop velocity closely. The yarn and hollow tips also produce only one or a few drop sizes and are suitable for use on very small areas only.

Characteristics Desired

To overcome some of the shortcomings of past rainfall simulators, these desired characteristics were formulated:

1 Drop size distribution of natural rainfall.
2 Drop fall velocity of natural rainfall.
3 Intensities in range of storms producing medium to high rates of runoff and erosion.
4 Satisfactory intensity and random drop size distribution over the area covered.
5 Minimum wind distortion.
6 Portability and ease of handling.
7 Use on standard size runoff plots.
8 Ability to reproduce a given storm.

The physical characteristics of natural rainfall which were desired in the simulated raindrops are shown in Fig. 1. The drop size distribution is as given for a rainfall intensity of 2½ iph by Laws and Parsons(9). The drop velocities are terminal velocities as found by Laws(8). Also shown in Fig. 1 are the approximate drop size distribution and fall velocities of the Type F nozzle as commonly used.

The kinetic energy of the water drops was selected for comparing the raindrop effect of simulated rainfall to natural rainfall. Wischmeier and Smith(17) indicated that the kinetic energy of the drops was the most suitable characteristic. In the kinetic energy relationship, $KE = \frac{1}{2} MV^2$, the velocity of drop fall is very important because it is squared. Laws(8) has shown that fall velocity is related to drop size and height of fall.

Wischmeier and Smith(17) found that the kinetic energy of rainfall was a function of intensity as: $KE = 916 + 331 \log I$, where KE is the kinetic energy in foot-tons per acre-inch and I is the rainfall intensity in inches per hour (iph). The kinetic energy of a 2½ iph rainfall is 1050 foot-tons per acre-inch and that of 5 iph is 1150 foot-tons per acre-inch. Approximate kinetic energy of a Type F nozzle as commonly used is 650 foot-tons per acre-inch.

Selecting the Nozzle

In an attempt to attain the desired characteristics, various household and garden nozzles, perforated irrigation pipe, variations of existing runoff study nozzles, sprinkler irrigation equipment, and commercial spray nozzles were investigated. The latter were found to best satisfy the desired features.

Study of all available commercial spray nozzles showed that only flat (fan type) pattern spray nozzles and square pattern nozzles gave reasonable intensity, drop size, drop velocity, and distribution characteristics. Tests showed that the square pattern nozzles had a much greater capacity than the flat pattern nozzles for similar kinetic energy. The flat pattern (Veejet) nozzles, therefore, were selected for use. These nozzles have a high flow rate. They produce a long, narrow spray pattern that decreases in intensity with distance from the center.

In order to use Veejet nozzles for the simulator, it was necessary to *(a)* move the nozzles during operation in the direction perpendicular to the long dimension of the spray pattern to cover greater area, *(b)* overlap adjacent nozzle patterns to improve intensity distribution, and *(c)* have the nozzles spraying only intermittently to hold the intensity to a reasonable rate. From extensive tests, the 80100 Veejet was found to have the best combination of drop size, drop velocity, and intensity.

The final design selected for the nozzles and their operation was:

1 *Nozzle*—Spraying Systems Company 80100 Veejet.
2 *Height*—8 ft above the soil surface. This height gives maximum spray width at an elevation which can be conveniently reached.
3 *Spray direction* — Downward, perpendicular to the soil surface. This results in minimized wind distortion and an initial drop velocity at the nozzle. Wind interference is not excessive in velocities up to 10 mph.
4 *Nozzle pressure* — 6 psi (4 gpm per nozzle). This pressure imparts a nozzle velocity of approximately 22 fps to the drops. The fall of 8 ft from the nozzle to the soil surface results in a drop velocity at impact very near to the terminal velocity of most drops.
5 *Distance between nozzles* — 5 ft parallel by 6 ft perpendicular to the long dimension of the spray pattern. The 5-ft distance provides the necessary overlap to give the best intensity distribution at the height and pressure used. The long dimension of the spray from one nozzle at the soil surface is 8 ft. Intensity variation within the 5-ft distance is less than 20 percent.
6 *Distance nozzles are spraying during movement*—6 ft. Therefore, one nozzle stops spraying at the same point that the preceding one began.
7 *Type of movement*—Reciprocating, with nozzles moving back and forth across slope.
8 *Intensities*—2½ iph (each nozzle spraying 20 percent of time) and 5 iph (each nozzle spraying 40 percent of time). These intensities are in the range of storms producing serious erosion. For the lower intensity, alternate rows of three nozzles each (see top of Fig. 2) spray during alternate trips across the plot in one direction. For the higher intensity, all nozzles spray each time across in one direction. No nozzles spray during the return trip or when reversing directions at the extremities of movement.

Using this design, the drop size distribution and the drop velocities shown in Fig. 1 were obtained. The kinetic energy produced by this design is approximately 800 foot-tons per acre-inch, or greater than 75 percent of the kinetic energy of natural rainfall at an intensity of 2½ iph. This is considered sufficient for most comparative studies.

Simulator Design

After selection of a suitable nozzle arrangement, the next step in the development was the design of the rainfall simulator framework. The basic framework of one simulator unit is illustrated in Fig. 2. Units can be joined at the sides and ends to vary the number and length of plots covered for a test run.

. . . Rainfall Simulator

Each unit covers an effective area of 18 ft across slope (three nozzles spraying 6 ft each) by 15 ft down slope (the distance between the outer of the four rows of nozzles) when used individually. However, each additional upslope unit covers 20 ft instead of 15 ft, because outer adjacent nozzle rows of successive units cover the 5 ft between them. Thus, one unit can cover a plot that is 15 ft long by 12 ft wide with a 3-ft border on both sides; two units can cover a plot of 35 ft by 12 ft, etc.

Each unit consists of two 22-ft aluminum I-beams (A in Figs. 2 and 3) which are held 10 ft apart by lengths of aluminum angle (B) and supported 7½ ft above the soil surface by aluminum pipe legs (C) of adjustable length. The wheels (D) of an aluminum carriage (E) to which the nozzles (F) are attached run in a channel fastened to the top of these I-beams. The carriage moves back and forth at a constant velocity by a method similar to that used on the Georgia Field Plot Irrigator (14).

The main units are located over the plot upslope from the drive engine and have the drive mechanism (G) that controls the movement of the carriages. One main unit is shown in Fig. 3. Side units do not have the drive mechanism because their carriages are connected to those of the main unit and are moved by them. One gasoline engine (H) powers all carriages by interconnected main drive shafts (J) on all main units.

The drive mechanism includes a 15-ft roller chain (K) located on the inside of both I-beams of a main unit. The carriage is moved by a drive rod (L) through the drive slots of the main unit carriage and attached to both chains. The chains travel continuously. The direction change of the carriage is accomplished by the drive rod sliding either up or down in the drive slot as the chain moves around the sprocket wheels. Successive units upslope are timed so that only one main unit carriage is changing direction at any one time.

The water to the nozzles is turned on and off by ¾-in. solenoid valves. Each valve feeds six nozzles. Since each unit consists of four rows of three nozzles each, two solenoid valves (M in Fig. 3), each controlling two alternate rows, are required per unit. The nozzles begin their application immediately after the carriage has reversed direction of movement and end after spraying for 6 ft and just before the carriage again reverses direction for the return trip. The solenoid valves for the nozzles are activated by DPST relays (N). The relays are activated by switches located along a chain (P) which is timed with the drive mechanism. Bleed solenoid valves (R), operated by SPDT relays, are also included to open when all feed valves are closed. Thus a constant rate of flow is maintained. To change from one intensity to the other during a run, it is only necessary to throw a knife switch on the relay board and adjust the water flow. Electricity for the solenoids, relays, and switches is supplied by a 12-v automobile battery.

Water for the rainfall simulator is supplied by an irrigation pump to the upper part of the series of plots being tested. The water must be supplied at 40 psi at the flow rate required. It is then conveyed through 3-in. irrigation pipes (one line per plot) to the solenoid valves. The irrigation pipe is fitted with an extra riser outlet 10 in. from the existing outlet so that the two feed solenoid valves required per unit may be located side by side. Since each solenoid valve supplies alternate rows of nozzles, only one of the two valves operates each time across at the 2½-iph intensity and both operate at the 5-iph intensity. Two successive units downhill are timed so that the carriage of one is traveling one direction while the second is traveling in the other. Since the nozzles spray in one direction only, the two units have the same water demand as one has when operated alone. Each pair of units consists of six solenoid valves: four feed valves and two bleed valves. The bleed valves are calibrated to give the same flow rate as the feed valves. One bleed valve is used for the low intensity and both are used when operating at the high intensity. A pair of units require 25 gpm of water at the low intensity and 50 gpm at the high intensity.

Beneath each I-beam are two lengths of 1-in. plastic pipe (see Fig. 3), each with three outlets at 6-ft intervals. From one feed valve, water is conveyed by two 1-in. plastic pipes to two of these outlet pipes, one beneath each I-beam of a unit. The other feed valve of the unit supplies the other two outlet pipes. Since the nozzles fed by the outlets beneath the upslope I-beam are at a higher elevation due to land slope than those supplied by the same valve but fed by the outlets beneath the down slope I-beam, the pipe from the valve to the upper outlet pipe is 5 ft shorter than that to the lower outlet pipe. This gives equal nozzle pressure on an average expected land slope of 6 percent.

Water is conveyed to each nozzle by a 5½-ft piece of ½-in. flexible rubber hose which is attached to the proper outlet by a snap coupling. Immediately prior to each nozzle is a ½-in. check valve that prevents drip from the lower row of nozzles after the solenoid feed valve closes. Alternate rows of nozzles are attached to supply pipes fed by the same solenoid valve.

The opening slit of each nozzle is set at a horizontal angle of 13 deg with the carriage bar to which it is attached. This angle is required to prevent the sprays of adjacent rows of nozzles from striking each other and distorting the in-

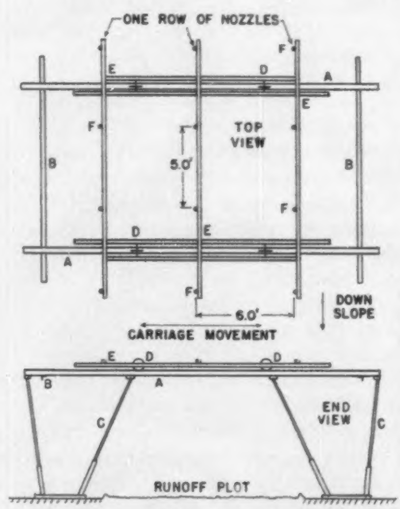


Fig. 2 The basic framework of one unit of the rainfall simulator

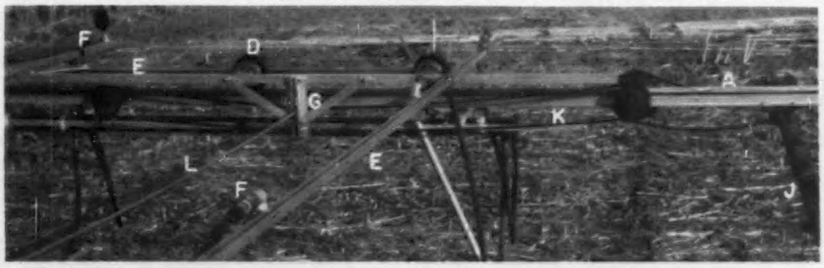
A. I-beam
B. Angle
C. Adjustable leg
D. Carriage wheel
E. Carriage frame
F. Veejet nozzle

tensity and energy patterns when operating at the higher intensity.

Each line of 3-in. irrigation supply pipe has an adjustable valve between each pair of downslope units. On more shallow slopes, the friction loss in the pipes as the water travels downhill from the upper part of the plot tends to equalize the supply pressure of the upper and lower units. On steep slopes, however, this valve is partially closed to maintain uniform pressure on all pairs of units. A slight variation in supply pressure is not serious since pressure losses between the entrance of the solenoid valve and the nozzles reduce the pressure from 40 psi to 6 psi. A small variation in 40 psi affects the 6 psi pressure very little.

The rainfall simulator is designed for use on adjacent plots with center-to-center distances of 18 ft. The test area itself may be any width up to 14 ft, with the remaining distance being border area. Each row of units is located over the center of a test plot, with the upper and lower ends of the plot placed beneath the center of a row of nozzles. Plot lengths, therefore, are normally in multiples of 5 ft. The simulated rain falling outside the test area on the sides and ends of the plots minimizes possible border effects. The number of plots upon which test runs may be made simultaneously and the length of each plot are limited only by the water supply and the number of units available.

Since plans called for numerous and often long-distance moves of the entire simulator, it is designed to facilitate transportation, assembly, and handling. Wherever possible,



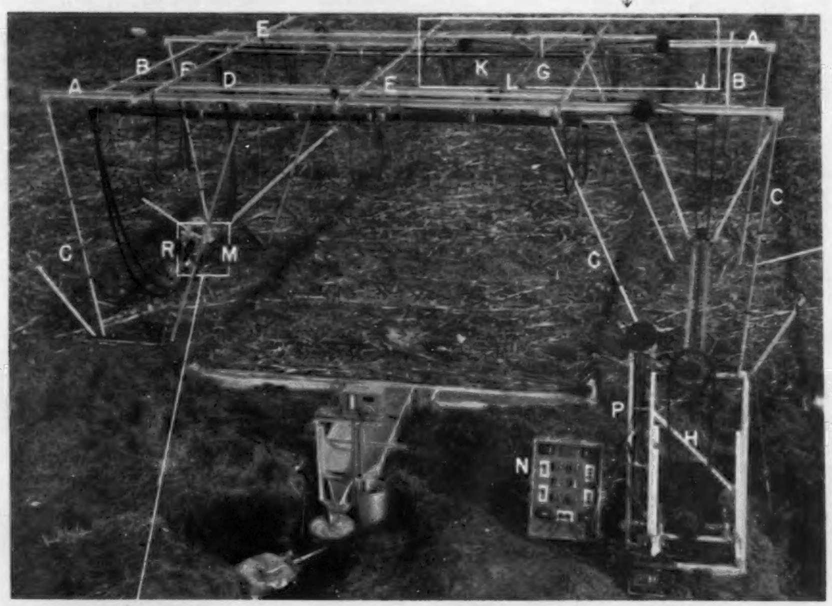


Fig. 3 One unit of the rainfall simulator

A. Aluminum I-beam
B. Aluminum angle
C. Aluminum leg
D. Carriage wheel
E. Carriage frame
F. Veejet nozzle and check valve
G. Drive mechanism
H. Gasoline engine
J. Main drive shaft
K. Drive chain
L. Drive rod
M. Feed solenoid valve
N. Relay board
P. Switch chain
R. Bleed solenoid valve

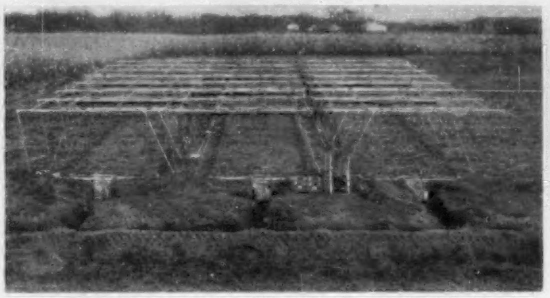


Fig. 4 Twelve units of the rainfall simulator operating on three runoff plots simultaneously. Each plot is 75 ft long by 12 ft wide plus borders. Runoff is measured by standard equipment

Fig. 5 The rainfall simulator ready for transportation to another location. Load includes 12 units, accessories, and 1000 ft of irrigation pipe

aluminum is used to keep weight to a minimum and prevent corrosion by weathering. Fast, simple methods speed up separating and assembling component parts. Individual pieces collapse into long, narrow, easily loaded shapes.

To date, 12 rainfall simulator units have been constructed. These include four main units and eight side units. These 12 units can cover three plots 75 ft long with borders (See Fig. 4). These twelve units with all necessary accessories and 1000 ft of 4-in. irrigation supply pipe can be conveniently transported on a 22-ft flat-bed trailer with a load height of 5 ft (See Fig. 5).

Measurements

The average intensity and amount of simulated rainfall are determined by water collected from 1-in. aluminum channels placed diagonally across the test plots. Runoff from each plot is collected by a trough extending across the bottom of the plot. A flume with stage recorder measures the runoff. An N-1 sampling wheel samples the flow from each flume for soil content determinations. Flow samples are taken periodically to determine the variation in soil loss during runoff. Measurements of physical characteristics of the plot site are also made.

Runoff study plots have been operated for many years throughout much of the United States. Data from these studies are being summarized(16, 18) and are yielding much information for use by soil and water management technicians. However, these summaries show that little or no data are available for some widely used current treatments and practices. Similar information is needed for new farming techniques that are continuously being developed.

Qualitative analysis of the soil and water loss characteristics of various slope-practice factors and the rating of various treatments in relative order will be of much use to land management technicians, even though quantitative values may not be directly obtained. Simulator results will be used to supplement the results from plots utilizing natural rainfall. Studies with natural rainfall may permit the assignment of quantitative values to some simulator results.

References

1 Borst, H. L. and Woodburn, R. Rain simulator studies of the effect of slope on erosion and runoff, 1938. SCS TP-36, 1940.

2 Diseker, E. G. and Yoder, R. E. Sheet erosion studies on Cecil clay. Ala. Agr. Exp. Sta. Bull. 245, 1936.

3 Duley, F. L. and Hays, O. E. The effect of the degree of slope on runoff and soil erosion, J. Agr. Res. 45: 349-360, 1932.

4 Ekern, P. C. Raindrop impact as the force initiating soil erosion. Soil Sci. Proc. 15: 7-10, 1951.

5 Ellison, W. D. Soil erosion. Soil Sci. Proc. 12: 479-484, 1948.

6 Ellison, W. D. and Pomerene, W. H. A rainfall applicator. AGRICULTURAL ENGINEERING 25: 220, 1944.

7 Hendrickson, B. H. The choking of pore space in the soil and its relation to runoff and erosion. Trans. Am. Geophys. Un. 14th Ann. Meeting, pp. 500-505, 1934.

8 Laws, J. O. Measurements of fall-velocity of water-drops and raindrops. Trans. Am. Geophys. Un. 22: 709-721, 1941.

9 Laws, J. O. and Parsons, D. A. The relation of raindrop-size to intensity. Trans. Am. Geophys. Un. 24: 452-459, 1943.

10 Lowdermilk, W. C. Influence of forest litter on runoff, percolation, and erosion. J. Forestry 28: 474-491, 1930.

11 Neal, J. H. The effect of the degree of slope and rainfall characteristics on runoff and soil erosion. Mo. U. Res. Bul. 280, April, 1938.

12 Nichols, M. L. and Sexton, H. D. A method of studying soil erosion. AGRICULTURAL ENGINEERING 13: 101-103, 1932.

13 Spain, J. M. and McCune, D. L. Something new in subsoiling. Agron. Jour. 48: 192-193, 1956.

14 Sparrow, G. N., Carter, R. L. and Stansell, J. R. Irrigator for research plots. AGRICULTURAL ENGINEERING. (In Press)

15 Wilm, H. G. The application and measurement of artificial rainfall on types FA and F infiltrometers. Trans. Am. Geophys. Un. 24: 480-487, 1943.

16 Wischmeier, W. H. Punched cards record runoff and soil-loss data. AGRICULTURAL ENGINEERING 36: 664-666, 1955.

17 Wischmeier, W. H. and Smith, D. D. Rainfall energy and its relationship to soil loss. Trans. Am. Geophys. Un. 39:285-291, 1958.

18 Wischmeier, W. H., Smith, D. D. and Uhland, R. E. Evaluation of factors in the soil-loss equation. AGRICULTURAL ENGINEERING 39: 458-462, 474, 1958.

19 Woodruff, C. M., Smith, D. D. and Whitt, D. M. Results of studies involving the application of rainfall at uniform rates to control plot conditions. Soil Cons. Exp. Sta., Bethany, Mo. (Mimeographed Report) June, 1938.

Materials-Handling Flow Diagram

A CLEVER materials-handling flow diagram for farms, based on the approach used by industry for mass production, appeared in the September issue of *Successful Farming*. The multi-color flow chart, prepared by S. S. De Forest, engineering editor, with technical assistance from M. W. Forth, agricultural engineer, Deere & Co., shows at a glance the flow of materials from field to storage, through processing, and finally, feeding or market. Provision is made also for following purchased materials or those returned to the field.

Also announced is the third edition of a series on materials handling, entitled Materials Handling – Ideas for Profitable Farming. The first editions were entitled Materials Handling – Newest Farm Science and Materials Handling – Make It a System, respectively. Copies of the latest, which includes the materials-handling flow diagram mentioned above, are available from Meredith Publishing Co., Des Moines, Ia., 35 cents per copy.

Flow Measurements for Sprinkler Irrigation Systems

A. W. Fry and J. R. Davis
Assoc. Member ASAE Member ASAE

THE first requisite of efficient water use is a precise measure of quantities or rates of flow of the water involved. However, due to the expense involved, many farmers object to purchasing a commercial flow meter; and many research agencies cannot afford the purchase of a number of commercial meters or the fabrication of precise Venturi or orifice meters.

This study was initiated in an attempt to evaluate several methods of fabricating accurate yet inexpensive rate-of-flow measuring devices for sprinkler irrigation pipe. It is not the intent of this paper to discourage the use of commercial flow meters, because of their obvious technical advantages; but to provide engineers with information that may encourage the measurement of flow heretofore unobtainable.

Objectives of Metering Equipment

Several requirements were stipulated for the evaluation of the methods used in this study:

1 A reasonable degree of accuracy.
2 A low head loss through the meter.
3 Relatively inexpensive to fabricate.
4 Easily fabricated with ordinary shop facilities.
5 Reproducible without having to calibrate each one.
6 Sturdy construction to withstand field abuse.
7 Adapted to either main lines or portable lateral lines.

Because of these requirements, the methods studied were limited to those utilizing a pressure differential or a measurement of velocity head.

Procedure

The devices involved in this study were adapted to 4-in. diameter aluminum tubing (3.90 in. I.D.) and are as follows:

1 Concentric circular orifice, 2.45 in. in diameter, made from 3/16-in. aluminum plate.
2 Square-edged eccentric orifice made from 3/16-in. aluminum plate, entirely suppressed, such that the effective area of the orifice was 50 percent of the cross-sectional area of the pipe.
3 Square-edged eccentric orifice similar to No. 2, with the effective area at the orifice equal to 70 percent of the cross-sectional area of the pipe.
4 Impact tube with two 1/16-in. holes drilled 0.5 *D* apart and equidistant from the center of the pipe, made from 1/4-in. copper tubing, placed perpendicular to the center line of the pipe.
5 Impact tube with one 1/16-in. hole at the center line of the pipe, otherwise similar to No. 4.
6 A modified Venturi meter, made by manually crushing the tubing between two steel channels which were subsequently bolted together.
7 Square-edged eccentric orifice similar to No. 2, with an effective area at the orifice of 76 percent of the

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The authors — A. W. FRY and J. R. DAVIS — are, respectively, junior engineer and acting associate irrigation engineer, irrigation department, University of California, Davis

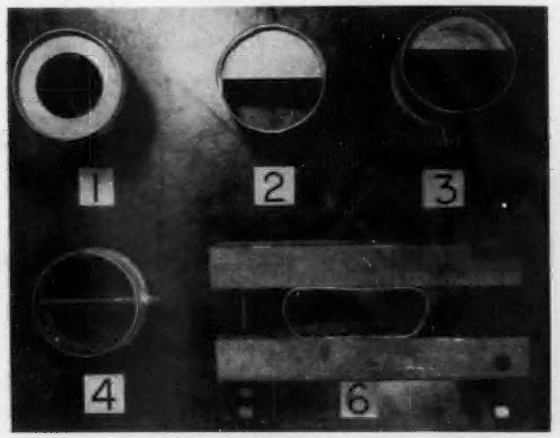


Fig. 1 *(Above)* End view of rate of flow measuring devices installed in aluminum tubing

Fig. 2 *(Right)* Square-edged eccentric orifice plate installed in steel press-on coupler

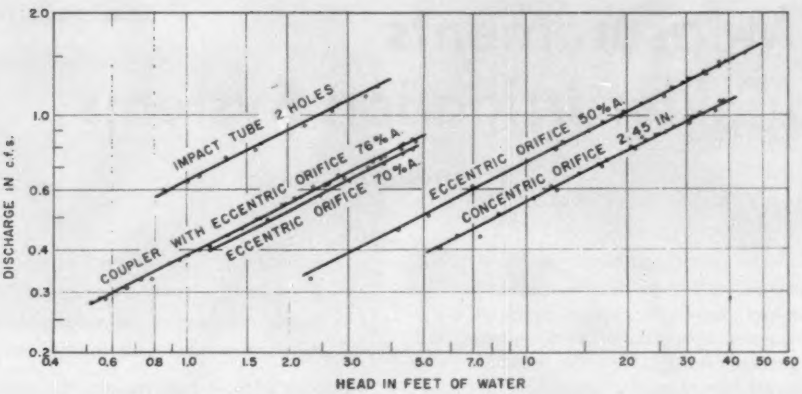


Fig. 3 Orifice calibration results

. . . Flow Measurements

cross-sectional area of the coupler installed in a steel press-on coupler (3.88 in. I.D.), with 20 ft of straight approach.

8 Same as No. 7 with 4 ft of straight approach.

The concentric orifice was installed by cutting a 20-ft length of pipe into two pieces, fitting the orifice plate to one end of one piece and welding the two pieces together. The square-edged orifices were installed by cutting a slot in the pipe or coupler perpendicular to the center line, placing an aluminum plate in the slot and welding a bead between the pipe or coupler and both sides of the plate. The impact tubes were inserted into the pipe through two diametrically opposite holes in the pipe, positioned and welded to the pipe. The modified Venturi was made by crushing the pipe between two 4-in. steel channels to form a symmetrical constriction. The channels were bolted together to prevent expansion of the pipe at high pressures. A summary of the material used and the labor involved is shown in Table 1.

TABLE 1. MATERIAL AND LABOR FOR WATER MEASURING DEVICES

Method	Material used	Labor, hours
1	3/16-in. aluminum plate 1/4-in. copper tubing	2-2½
2	"	1-1½
3	"	1-1½
4	1/4-in. copper tubing	1-1¼
5	"	1-1¼
6	Channels-nuts-bolts 1/4-in. copper tubing	¾-1
7 and 8	Steel press on coupler 3/16-in. aluminum plate 1/4-in. copper tubing	1-1½

The orifice pressure taps were installed 0.5 D downstream and 1.0 D upstream from the plate in the pipe, and 0.5 D both ways in the coupler; and on the same side of the pipe as the orifice plate in line with the deepest section of the orifice plate. With the impact tubes the pressure tap was installed 1.0 D upstream; and with the Venturi, taps were placed in the center of the constricted area and 4.0 D upstream. All taps were placed flush with the inside surface of the pipe, and all burrs removed to avoid unnecessary errors in pressure measurement.

The desired ranges of flow and pressures for the tests were obtained by means of a variable speed pump and a control valve downstream from the test section. All flows were measured with a calibrated volumetric tank. Tests were conducted at 40, 70 and 100 psi for flow rates in the range of 0.5 to 1.0 cfs.

A differential U-tube manometer was used to measure the differential heads in the test sections. Because the heads differed considerably, mercury was used as a manometer fluid for devices 1 and 2, an air-water inverted U-tube manometer for devices 3, 4, 7 and 8, and a manometer fluid (Sp. Gr.$=$1.75) for devices 5 and 6. All measurements were then converted to head in feet of water.

Results

A regression analysis was applied to the data collected during the calibration tests to determine the best statistical fit of an equation and the standard error of estimate for the line of regression. Because the exponent of h, the differential head, in all regression equations so closely approximated 0.5, the regression equations were modified for simplicity and practicability and are shown in Table 2 as modified

TABLE 2. ANALYSIS OF FLOW MEASUREMENT METHODS

Method	Modified regression equation*	Standard error of est., cfs	Head loss, feet
1 Concentric orifice	$Q=0.173h^{0.5}$	0.010	$0.61h$†
2 Square-edged orifice 50 percent of area	$Q=0.228h^{0.5}$	0.005	—
3 Square-edged orifice 70 percent of area	$Q=0.370h^{0.5}$	0.004	$0.30h$‡
4 Two-hole impact tube	$Q=0.634h^{0.5}$	0.008	Negligible†
7 Coupler with 76 percent A 20-ft approach	$Q=0.386h^{0.5}$	0.010	$0.27h$‡
8 Coupler with 76 percent A 4-ft approach	$Q=0.386h^{0.5}$	0.005	$0.27h$‡

*Q is expressed in cfs and h in feet of water.
†Taken from published data not verified in tests.
‡Calculated by subtracting pipe friction loss (see ref. 2) from measured total loss in a 19-ft section of pipe.

regression equations, in which the exponent of h is 0.5. The standard error of estimate still pertains to the line of regres-

sion and reflects the accuracy of measurements of any one method.

Considerable difficulty and error were encountered in the measurements of head with the one-hole impact tube and the modified Venturi, due principally to air entrapment in the aluminum pipe. These results were thus deemed invalid and are not reported. Since the one-hole impact tube is inherently less accurate than a two-hole impact tube and since the modified Venturi would be very difficult to reproduce, these methods are not considered practical and are not recommended.

The results of the analyses are shown graphically in Fig. 3.

Conclusions

On the basis of accuracy, ease of construction and adaptability to field conditions, a square-edged orifice appears to be quite practical for measurement of flow in sprinkler systems. It is simpler to construct and install in the pipe than a concentric orifice and allows the use of an air-water manometer, a distinct advantage for field use. This method of measurement is accurate over the desired range of flow and could easily be fabricated on a mass production basis.

Although the two-hole impact tube was fairly accurate, difficulty could be expected with use in the field due to clogging of the holes with debris, corrosion and salt encrustations. The modified Venturi would be particularly difficult to reproduce with any degree of accuracy.

None of the measurements were affected by the pressure in the pipeline.

Summary

Several methods of measuring the rate of flow in aluminum sprinkler pipe were evaluated in an attempt to reduce the high cost required by the use of commercial meters and encourage the measurement of water applied through sprinkler lines. Of eight methods tested, a square-edged eccentric orifice appears to be the most accurate and easily fabricated. The orifice and pressure tap can be installed in a length of aluminum tubing or a press-on coupler in 1-1½ hr with little additional cost and with common shop tools. It is sturdy and can be used with an air-water manometer, making it satisfactory for field use by relatively unskilled persons. The possibility of a prefabricated orifice in a press-on line coupler appears particularly promising.

References

1 King, Handbook of hydraulics, McGraw-Hill, New York, 1954.

2 Willardson, L. S. Energy losses in aluminum irrigation pipes due to deflections in couplers, 1955. Unpublished M.S. thesis. Copy on file in library, Utah State Univ., Logan.

. . . Light Transmittance

(Continued from page 643)

The performance of the instrumentation with the automatic compensation for system response is shown in Fig. 7. The system response as shown in curve (A) was recorded in conducting ink on the X-Y recorder. After correction, the flat response, curve (B), was recorded on the strip-chart recorder with no sample in the beam. Curve (B) as shown here is a tracing of the recorded curve. Considerable noise signal is apparent on this curve, but the maximum noise peak is only 2 percent of the full scale. This can be reduced considerably by filtering and operating at a reduced scanning speed. The transmittance recorded for a didymium glass filter is shown in curve (C) to demonstrate the capabilities of the instrumentation. These curves were recorded with a scanning speed of 150 $m\mu$ per min with a slit width of 0.5 mm.

The stability of the system operating with a flat response characteristic has been found to be such that the same correction curve can be used after an interval as long as two weeks. It has not been tested over a longer period on the same curve. To obtain this stability the lamp output must be stabilized as well as the voltages to the phototubes. This is accomplished by operating the whole instrument from an electronic line-voltage regulator which holds the line voltage constant to better than ± 0.1 percent.

Possible Applications

Only a few of the possible applications of this type of instrumentation have been described here. Some additional applications include the measurement of the internal color of tomatoes as described by Birth, Norris, and Yeatman(2), the detection of hollow heart in potatoes as described by Birth and Norris(1), and the measurement of the color of the yolk of an intact egg as described by Brant and Norris (3). The detection of blood in an intact egg by light transmittance has been developed to the stage of automatic sorting of white eggs at the rate of 120 eggs per minute. This development shows the real possibility of the light transmittance technique, because the same type of measurement is required for indicating the other quality factors.

This type of instrumentation also has a wide application to research in plant physiology because it makes possible the study of reactions taking place in living tissues. For such applications it is desirable to extend the short wavelength response into the ultraviolet region. The use of different phototubes and an energy source having a higher output in the ultraviolet region makes this possible.

Summary

Instrumentation has been developed for measuring the light transmittance characteristics of intact agricultural commodities. This instrumentation makes it possible to record the spectral transmittance of intact apples, peaches, eggs, tomatoes and most other fruits and vegetables. The transmittance measurement is shown to be useful in indicating maturity, internal color, and detection of internal defects. It is also shown that it is possible to make such measurements at a speed sufficient to permit automatic sorting.

References

1 Birth, G. S. and Norris, K. H. A nondestructive technique for detecting internal discolorations in potatoes. (Abstract) Program of 41st Annual Meeting Potato Assoc. of America, December 1957.

2 Birth, G. S., Norris, K. H. and Yeatman, J. N. Nondestructive measurement of internal color of tomatoes by spectral transmission. Food Tech. Vol. 11, No. 10, p. 552-557, 1957.

3 Brant, A. W. and Norris, K. H. Mechanizing the determination of quality in shell eggs. Proc. Tenth World's Poultry Congress, August 1954.

4 Brant, A. W., Norris, K. H. and Chin, Gilbert. A spectrophotometric method for detecting blood in white-shell eggs. Poult. Sci. 32: 357, 1953.

5 Clothier, W. K. and Hawes, F. C. A tuned differential amplifier for low frequency bridge. Aus. Jour. Appl. Sci. Vol. 1, 38-44, 1956.

6 Kramer, A. and Smith, H. R. Electrophotometric methods for measuring ripeness and color of canned peaches and apricots. Food Tech. 1: 527-539, October 1947.

. . . Energy Requirements

(Continued from page 639)

formly, a scale for dullness was made up. One pair (medium) had a flat 0.005 in. thick leading edge. The other pair (dull) had a 0.010 in. flat leading edge while a third pair was classified as sharp.

Fig. 8 shows the energy required to cut second cutting 35-day alfalfa using the three pairs of knives. As would be

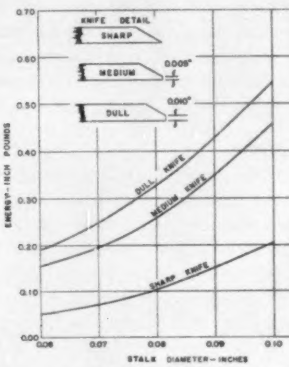


Fig. 8 Effect of knife dullness in alfalfa

expected the energy required to cut the individual stalks increased both with stalk diameter and thickness of leading knife edge.

The effect of knife dullness is further brought out in Fig. 9 which compares each pair of dull knives with the sharp knife data. It is observed that the effect of knife dull-

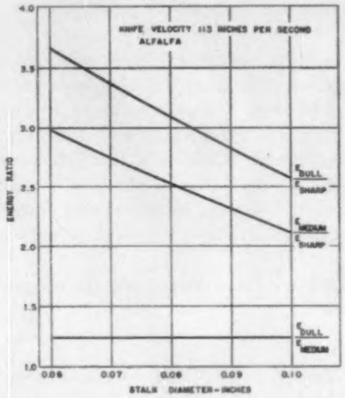


Fig. 9 Comparison of energy requirements when using dull knives

ness is more pronounced with the smaller diameter stems. It is possible that the character of the cutting action changes as the stalk diameter increases. The included angle of the knife results in a wedge-like action which causes fiber failure in tension rather than in shear.

The energy requirement of the dull knife compared with that of the medium dull knife shows little or no relation to stalk diameter. This value remains rather constant at 1.26. Therefore, it appears that once the knife became dull, further dulling would increase the energy requirement and would be independent of stalk diameter.

This work is summarized in Progress Report 17, Storrs Agricultural Experiment Station, entitled "An Evaluation of the Energy Required to Cut Forage Grasses and Legumes."

. . . How Efficient?

(Continued from page 629)

ures and on performance are recorded, calculations made and correlated. The planning and analyzing are necessarily a job for the engineering staff. In this process all these facts are translated into factors which may be coded or channeled into various categories relating to machine performance. For example, the ratio between replacements of a certain part and the number of machines in operation becomes a factor for that part.

Many industries are now using electronic data-processing systems in various technical applications. Automobile manufacturers use it for controlling materials in production, stocking spare parts, handling warranty claims and for various technical computations. So far in this industry the system has not been primarily oriented to engineering design. There is no limit to the assortment of the data that may be processed nor the kinds of problems to which they may be applied. For example, and this may also apply more particularly to automobiles, the matter of mechanical accessibility, from the standpoint of service, is a constant problem and one that is often annoying and costly. Another area is that of safety where continuous analysis of after-the-fact data might provide some answers by way of engineering or by education and warning to drivers.

In effect, the system can become a new engineering instrument with far-reaching possibilities. The electronic brain has unfailing memory, complicated calculations become routine, and answers to questions are almost instantaneous. Thus, it can be made to feed out information almost without end to guide engineering.

Farm machines operate under varied conditions and extremes in heat, frost, dust, sand, rocks, crop stands and rough fields. But a machine, like the chain, is no stronger than its weakest link. If any vital part breaks or wears out, everything stops. One by one these weak links yield until the machine is discarded. To improve the machine we must first spot these weaknesses as quickly as possible and then find ways to correct them. It is a sort of modern-day counterpart of Oliver Wendell Holmes' concept expressed in the "Wonderful One Hoss Shay."

Of course there are definite limitations to changes or kind of alterations that can be made in a product once in the production stage. It may not always be possible or practical to change a part or a unit without a costly interruption. Nonetheless, it is important to have full and continuous flow of information on the performance of the product, on any weaknesses that may develop, and to pinpoint trouble spots as the number of units increases and work conditions become more varied. What measures are taken to make improvements or to meet each situation become engineering and management decisions.

The May, 1923, issue of AGRICULTURAL ENGINEERING reported in some detail a system on "How Field Experience Can Influence the Design of Farm Machines." This was based on a system which I put into effect with a tractor manufacturer to cover two new tractors for a period of two years. It was an elementary version of the plan that has been outlined here. All recording and computing of data were performed by office clerks. The system entailed tedious paper work and figuring, but it soon provided some startling revelations and results.

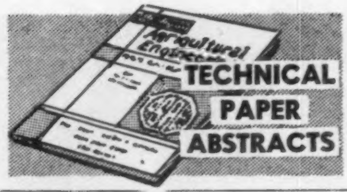
The pilot tractors had undergone rigid testing and months of field work before regular production was started. Yet within two weeks after delivery of the first tractors to customers, reports began to indicate certain functional tendencies and mechanical weaknesses. By careful analysis definite trends were quickly established. All available factors involved in the design and production were studied. Within a few months forty-seven important changes or alterations had been made in the two tractors. These include changing steel in rear axle to improving water passages and circulation in the cylinder head. Minor improvements and elimination of "bugs" continued to be made in both tractors for some time.

Under normal procedures some of the improvements mentioned would have been made, but the improved reporting system and accurate analysis of the difficulties speeded the process of changes, saved considerable expense and held to a minimum the number of tractors subject to these failures from getting into the hands of customers.

But beyond this immediate function, the greater value in the system undoubtedly may lie in the "piling up" of information and experience data to guide the engineering of new machines. This massive and

(Continued on page 670)

Following are brief reviews of papers presented at ASAE meetings or other agricultural engineering papers of which complete copies are available. Information concerning copies of these papers may be obtained by writing to the American Society of Agricultural Engineers, St. Joseph, Mich.



Instrumentation for Measuring the Spectral Response of Insects, by R. A. Stermer, agricultural engineer, AMS, USDA, Texas A & M College, College Station. Paper presented at the Annual Meeting of ASAE, Santa Barbara, Calif., June 1958, on a program arranged by the Electric Power and Processing Division. Paper No. **58-108.**

This paper is a presentation of instrumentation developed for measuring the spectral response of stored products insects to electromagnetic radiation. Instrumentation was developed for isolating narrow wavebands of radiation between 280 and 600 mu. A satisfactory technique was developed for presenting the narrow wavebands of radiation to the insects to test their response. The intensities were kept constant at all wavebands which required spectral calibration of the intensity measuring equipment. This included a multiplier phototube and its associated circuit, a d.c. power supply, and a vacuum tube millivoltmeter.

The author reports that nine wavebands extending from 280.4 to 600.0 mu were used with seven species of stored products insects. Four of these species showed the greatest preference for a waveband near 500.0 mu, in the green portion of the spectrum with a secondary preference for a waveband near 350 mu. One species, the Indian-meal moth, showed a highly significant preference for near ultraviolet with a secondary preference for the green, 500 mu. Still another species, the rice weevil, showed no preference for wavebands between 334 and 546 mu. All species were unattracted to wavebands below 300 mu and only slightly attracted by wavebands at 405 and 600 mu.

Rotary Tillage Characteristics—a Quantitative Evaluation of Present Concepts, by W. J. Adams, Jr. and Donn B. Furlong, respectively, assistant manager, Central Engineering Department, Food Machinery and Chemical Corporation, San Jose, Calif., and chief development engineer, Bolens Products Division, Food Machinery and Chemical Corporation, Port Washington, Wis. Paper presented at the Annual Meeting of ASAE in Santa Barbara, Calif., June 1958, on a program arranged by the Power and Machinery Division. Paper No. **58-58.**

The authors discuss the tremendous impact that rotary tillage has had on power gardening in recent years. They report that most of the criticism of rotary tillers for soil preparation is concerned with high horsepower consumption and over-working the soil. The scope of this paper pertains to the gatnering of experimental data and analyzing characteristics of tiller variables and parameters in the interest of leading to improved future design and performance.

A research testing machine was developed and the characteristics of rotary tillage were determined in order to compare performance in terms of rotor and traction horsepower, rotor reaction forces, and cutting, dispersion and pulverization characteristics. Three basic type tines (hoe, slicer, and pick) were evaluated in respect to each other as well as their respective performance. Test results are given in terms of hardness of sub-bed, power requirements, speeds, increments of cut and width of rotor.

Some Mechanical and Rheological Properties of Grains, by G. C. Zoerb and C. W. Hall, respectively, associate professor of agricultural engineering, South Dakota State College, and professor of agricultural engineering, Michigan State University, East Lansing. Presented at the Annual Meeting of ASAE at Santa Barbara, Calif., June 1958, on a program arranged by the Farm Structures and electric Power and Processing Divisions. Paper No. **58-11.**

This paper describes SR-4 strain gage equipment developed to measure mechanical and rheological properties of grains and presents results of the study. Included are results of load and deformation relationships obtained by amplifying the output from two strain gage bridge circuits, and recording them on a two-channel oscillograph. Three grains, soft red winter wheat, yellow dent corn, and pea beans were studied.

An account is given of the chief parameter investigated—the effect of moisture content on kernel properties — as well as a study relating to the effect of rate of deformation and the relation of kernel position (edge or flat) to strength characteristics.

The principal rheological property examined in the investigation was stress relaxation with time under various conditions for pea beans. A two-term exponential equation was obtained graphically to express the stress relaxation—time relationships.

Mechanical Fruit Harvest — Olives, Peaches, and Pears, by L. H. Lamouria, H. T. Hartmann, R. W. Harris, and C. R. Kaupke, respectively, associate professor of agricultural engineering, associate professor of pomology, assistant horticulturist, and assistant specialist in agricultural engineering, University of California. Presented at the Annual Meeting of ASAE at Santa Barbara, Calif., June 1958, on a program arranged by the Power and Machinery Division. Paper No. **58-64.**

The results of six years of research are presented in this paper with the authors relating the following indications regarding machine harvesting of fruit: (a) With tree-shaking equipment, table olive fruits were mechanically harvested onto catching frames with about 16 percent of the hand-harvest labor normally required and 30 percent of the hand-harvest costs. (b) Oil olives were mechanically harvested with about 10 percent of the labor that would have been required for hand harvest and 30 percent of the hand-harvest costs. (c) Although more scarring of the fruit occurs with mechanical harvesting than with hand picking, processing of table olives by the black-ripe method effectively masks the scars. (d) Clingstone peaches were mechanically harvested with over 75 percent of the fruit free of visible injury immediately following harvest. Pear injury varied with tree height. (e) The vigorous shaking given the trees by the boom shaker equipment produced very little limb breakage and apparently no tree injury. (f) Tree structure and fruit maturity are the greatest deterrents to the successful mechanical harvest of deciduous fruit destined for the cannery.

The paper includes a description and comparison of equipment used in the investigations and calculated harvest costs for olives based upon field findings.

Development of a Mechanical Harvester for Green Asparagus, by Robert A. Kepner, professor of agricultural engineering, University of California, Davis. Paper presented at the Annual Meeting of ASAE, Santa Barbara, Calif., June 1958, on a program arranged by the Power and Machinery Division. Paper No. **58-63.**

Hand cutting of asparagus is a selective operation, with only those spears that exceed a specified minimum height being cut each time the field is gone over. During most of the two to three-month harvest season in California, the beds are cut daily. Hand-harvesting costs currently represent about 40 percent of the gross income from the crop.

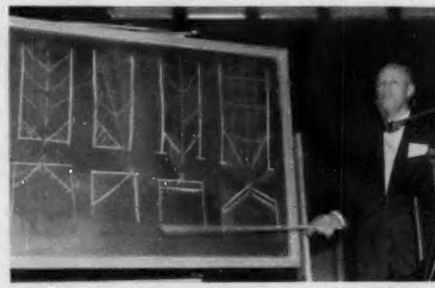
This paper describes a mechanical harvester developed by the University of California which is non-selective, cutting all emerged spears, regardless of length. Harvesting is at intervals of 5 to 8 days rather than daily. The author reports that at a speed of 3½ mph, one machine, with operator, should be able to take care of 125 acres and would replace about 15 hand cutters. Engineering problems and operating features are discussed.

A Ten-Year Summary of Psychroenergetic Laboratory Research, by R. G. Yeck and R. E. Stewart, respectively, agricultural engineer (AERD - ARS), USDA, and professor of agricultural engineering, University of Missouri. Presented at the Annual Meeting of ASAE at Santa Barbara, Calif., June 1958, on a program arranged by the Farm Structures Division. Paper No. **58-202.**

This paper is a result of a ten-year cooperative research at the Psychroenergetic Laboratory at Columbia, Missouri, in which the authors relate research findings indicating three temperature zones for dairy cattle; a low-temperature zone (below 30 F for Jerseys and below 10 F for Holsteins), an optimum-temperature zone (30 to 75 F), and a high-temperature zone (above 75 F). High relative humidity and thermal effects of radiation accentuated the deleterious effects of high temperature, whereas, wind somewhat ameliorated the effects of high temperature. Holstein cows were less heat tolerant than Jersey and Brown Swiss cows. A 40 percent relative humidity at 85 F caused very little drop in milk production among any of the three breeds, but when raised to 90 percent at 85 F, Holstein production dropped as much as 30 percent (Jerseys dropped about 25 percent, and Brown Swiss dropped about 20 percent). Ten-mph winds at 95 F were responsible for recovering 41 to 77 percent of 0.5-mph losses at 95 F. Radiation that simulated only one-half of maximum summer radiation caused appreciable losses in milk production at temperatures as low as 70 F. Other physiological measurements showed similar effects of temperature stress. Stable heat and moisture dissipation rates at various environmental temperatures were recorded. Heat dissipation decreased, whereas, moisture dissipation increased with rising stable temperatures. *(Continued on page 666)*

Farm Materials Handling Conference Attracts Over 400

Registration was handled most efficiently by *(left to right)* Beverly Jenks, Kay Mikkelsen and Bert Braland. Mary Ann Harms, not shown, assisted during the second day



(Above) Henry J. Barre, consulting agricultural engineer, points out the principles involved in flow of bulk granular materials during the Wednesday afternoon session

(Left) Smiles, displayed by members of the ASAE Committee for Conference on Materials Handling following the Thursday evening banquet, register satisfaction and pride in a job well done. *(Left to right)* Marvin Nabben, D. F. Shimon, M. W. Forth (vice-chairman), R. W. Kleis, F. W. Andrew, C. K. Otis, S. S. DeForest (chairman) and N. H. Curry (chairman of local arrangements committee). Other committee members not shown are W. M. Carleton (chairman of program committee), W. J. Liddell, G. L. Hazen, and G. W. Isaacs

A TOTAL of 40 states were represented during the first ASAE-sponsored Farm Materials Handling Conference which was held at Iowa State College September 17 and 18. The two-day event, followed by the annual Iowa Agricultural Engineering Field Day, also attracted representatives from Canada, Denmark, England, Russia and Sweden.

The auditorium of the Memorial Union was filled to capacity for the entire program, consisting of two daytime sessions for presentation of papers and an evening session for showing of motion pictures and slides. A total of 427 registered for the conference — 199 representing industry or private enterprise, 153 representing public service organizations, 57 students and 18 farmers. Over 300 attended the Thursday evening banquet. A turnout of 23 representatives of the press and radio from all parts of the country might be considered a good indication of the interest being developed in the subject of farm materials handling. During the conference Milt Bliss, agricultural representative and producer, National Farm and Home Hour, National Broadcasting Co., Inc., recorded interviews with S. S. DeForest, G. H. Seferovich and K. K. Barnes for presentation on the Saturday, September 20, National Farm and Home Hour radio program.

George H. Seferovich, editor of *Implement & Tractor,* in his introductory speech referred to the conference as "an opening wedge to getting materials handling ideas down to the farm level." In his presentation he outlined a procedure by which engineers, economists, farm managers, and equipment production and marketing people can successfully tackle problems of materials handling on farms. Although Carl Hall was touring Russia at the time of the conference, he made his own presentation with the aid of effective slides and a taped recording. F. H. Buelow was on hand to answer any questions in Carl's behalf. W. W. Gunkel, H. J. Barre and M. E. Singley, in three separate papers, presented principles of handling farm materials by type of material —liquid, free-flowing and non-free-flowing, respectively.

Motion pictures and slides on bulk potato handling by A. H. Glaves, handling of cherries and apples by J. H. Levin, handling of cotton from field to ginning by J. A. Luscombe, handling sweet corn, peas, and beans by M. O. Marmorine, and handling of poultry and livestock materials by Thayer Cleaver, were shown on Wednesday evening.

The second day of the conference was devoted to two papers on the handling of liquid materials, one on handling free-flowing materials, three on handling non-free-flowing materials and three on handling unit (batch) materials.

All papers presented during the conference were published in the September issue of AGRICULTURAL ENGINEERING. A limited number of issues are still available from ASAE headquarters.

Kirk Fox, editor emeritus, *Successful Farming,* in summing up the conference during the Thursday evening banquet, stated that agriculture is not a declining industry, but one with many opportunities. He pointed out how the comfort of farm life has been improved during recent years and advancements in the field of materials handling, by taking the drudgery out of farm chores, will result in remarkable changes in quality and cost of agricultural products possibly in the next ten years.

On Friday 32 exhibitors of farm equipment took part in the Annual Iowa Agricultural Engineering Field Day, sponsored by the agricultural engineering department of Iowa State College. Actual crops were grown in the demonstration area in order that displays and exhibits could demonstrate materials handling from field to storage, through processing, to livestock or market.

Student Honor Winners

Student honor awards, consisting of a certificate and gold key, are given annually by ASAE in recognition of outstanding scholarship attainments and general participation in student activities. Following are the winners elected by their respective student branches for the 1957-58 school year: Jimmy L. Carpenter, Iowa State College; Joe E. Clayton, University of Arkansas; L. Edwin Coate, Oregon State College; Cecil D. Davies, Kansas State College; Robert DeGraff, Purdue University; Harvey Hamilton, Oklahoma State University; James Hammerle, Pennsylvania State University; Ronald Holt, University of Illinois; Charles Bennett Johnson, Kansas State College; Roy L. Johnson, Texas Technological College; Fred D. Kaser, Oregon State College; Donald F. Kindler, Colorado State University; Larry G. King, State College of Washington; Alvin E. Klouda, Iowa State College; James F. Koelling, University of Missouri; James W. Lacy, University of Georgia; Jerry R. Lambert, University of Florida; Linwood E. Lufkin, University of Maine; Lowell McCunn, Iowa State College; Robert McFall, Kansas State College; Richard J. Mullins, Iowa State College; Ronald T. Noyes, Oklahoma State University; Donald E. Pepper, University of Missouri; Carl T. Peters, University of Arkansas; Walter M. Roll, University of Illinois; John Beverley Rose, Virginia Polytechnic Institute; Norman R. Scott, State College of Washington; Gerald D. Simmons, North Carolina State College; William A. Simon, University of Idaho; Quentin E. Smart, University of Maine; Donald L. Smith, University of Illinois; John S. Smith, Jr., Virginia Polytechnic Institute; Lee H. Snyder, Pennsylvania State University; Lex W. Strickland, University of Georgia; Carl W. Toney, North Carolina State College; Bob L. Whaley, University of Idaho; Edward Nash Williams, University of Georgia.

(Below) Soviet delegation included the Farm Materials Handling Conference in its itinerary. *(Left to right)* K. S. Radin, vice-minister, Ministry of Agriculture in Ukraine, USSR, Kiev; A. A. Schlikhter, associate professor of agricultural economic science and chief of agricultural problems division, Institute of World Economy and International Relations, Academy of Science, USSR, Moscow; G. L. Smirnov, engineer of electrical mechanization, Ministry of Agriculture, USSR, Moscow; I. A. Budzko, professor in All Union Academy of Agriculture, doctor of technical science, and director of All Union Institute of Rural Electrification, Moscow; O. K. Nichyporuk, associate in science of All Union Institute of Agricultural Economics, Moscow; and M. P. Novikov, engineer of electrical mechanization, Ministry of Agriculture, USSR, Moscow

(Above) The registration list revealed a variety of interests by those who attended the conference. Standing *(left to right)* are E. M. Lewis, manager of agricultural development, Oklahoma State University; K. W. Westerberg, president, Farm Engineering Sales, Inc., Savage, Minn.; Wallace Ashby, chief, livestock engineering and farm structures research branch (AERD, ARS), USDA, Beltsville, Md.; R. O. Gilden, Agricultural Engineering Federal Extension Service, USDA, Washington, D. C.; and Thayer Cleaver, agricultural engineer (AERD, ARS), USDA, University of California. Seated *(left to right)* are M. L. Todd, consulting engineer, Todd, Hedeen & Associates, Waterloo, Iowa; E. F. Schneider, vice-president, farm equipment product planning, International Harvester Co., and E. G. McKibben, director of Agricultural Engineering Research Division, ARS, USDA and President of ASAE

AE Scholarships Announced

The University of California has announced availability of the Harry B. Walker Agricultural Engineering Scholarship to graduate students who are citizens of the United States and who declare interest in academic and research activities. The $500 annual award has been made possible by the late Professor Walker (past-president and honorary member of ASAE) and augmented by funds donated by his friends and students.

An agricultural engineering scholarship of $300 also has been made available recently at Ohio State University by J. L. Child, Jr., a member of ASAE, through the Hancock Brick and Tile Company where he is employed as sales engineer. The same amount is also contributed for an agricultural engineering scholarship each year at Ohio State by the Standard Oil Company. It has been reported also that alumni of Ohio State have been contributing to the development fund for a similar scholarship as a tribute to the McCuens. Professor G. W. McCuen is past-president and life fellow of ASAE and former department head at OSU.

Journal Paper Awards

The following are the top ten papers published in AGRICULTURAL ENGINEERING during 1957. They are arranged in the order of highest scores as judged by the Committee on Paper Awards — B. L. Bondurant (chairman), J. E. Harmond, G. A. Karstens, and T. O. Hodges.

Authors and titles of the five winning papers are C. F. Kelly, T. E. Bond, and N. R. Ittner, "'Cold Spots' in the Sky May Help Cool Livestock;" F. H. Buelow and J. S. Boyd, "Heating Air by Solar Energy;" C. E. Ball, "Imagineering — The Next 50 Years;" Henry Giese, "ASAE — Its Founding and First Fifty Years;" and A. W. Cooper, G. E. VandenBerg, H. F. McColly and A. E. Erickson, "Strain Gage Cell Measures Soil Pressure."

Those receiving honorable mention are J. W. Crane and W. M. Carleton, "Predicting Pressure Drops in Pneumatic Conveying of Grain;" R. W. Brittain and W. M. Carleton, "How Surfaces Affect Pesticidal Dust Deposition;" M. E. Singley, "Self-Feeder Silo Controls Silage Flow;" H. E. Pinches, "Tomorrow's Agricultural Engineers—Their Opportunities;" and H. A. Myers and W. G. Lovely, "Granular Insecticide Applicators for Control of European Corn Borer."

Blue Ribbon Awards for Annual Meeting Exhibits

Public service and industrial organizations from all parts of the country displayed exhibits at the 1958 Annual ASAE Meeting at Santa Barbara, Calif., in June, with classifications including demonstration models, slides, bulletins, periodicals, movies, radio and television, and methods outlines.

Public agency class winners for the demonstration models were R. B. Furry, Cornell University, with a demonstration on tilt-up tools and E. H. Davis, University of Idaho, whose demonstration was on a portable hog house. United States Steel Corporation's "Pole Barn" was the winner in the industrial class.

The slides winner was Thayer Cleaver, USDA, ARS, Davis, Calif., with "Plastic Sheep Shelters."

Winners in the public agency class for bulletins included Burton S. Horne, Pennsylvania State University, with a bulletin on tools for pasture renovation; Paul R. Hoff, Cornell University, on corn picker pointers, and McCordic and LaRock, University of Wisconsin, on the well-planned kitchen. Bulletins winner in the industrial class was Portland Cement Association, with "Concrete Improvements for Cattle Feedlots."

Periodicals winners included Kansas State College in the public agency class whose periodical was on engineering in balanced farming, and Portland Cement Association, in the industrial class, with "Rural Concrete Builder."

Winners of the movies award in the public agency class were Ohio State University

F. L. Harrison, midwest branch manager, Oliver Corp., A. B. Farquhar Div., *(left)* has a question for Kirk Fox, editor emeritus, *Successful Farming*, following an address on the job ahead for materials handling by Mr. Fox at the Thursday evening banquet

demonstrating "Tractor Tragedy" and University of Nebraska with a movie on irrigation practices. In the industrial class, the winners were Portland Cement's "Concrete Example," New Holland Machine Company's movie on hay in a day, United States Steel Corporation's "Box Silo," and the movie on 4-H tractor trails, by Standard Oil Co. (Indiana), Standard Oil Co. (Ohio), American Oil Co., Utah Oil and Refining Co., and Humble Oil and Refining Co.

Radio and television winner was Donald P. Brown, Michigan State University on electricity at work.

Methods outlines winners included C. S. Winkelblech, Cornell University, on television farm short courses; D. G. Jedele and F. W. Andrew, University of Illinois, on drying and storage programs; T. C. Skinner, University of Florida, on farm fencing clinic; and J. D. Netherton, North Carolina State College, on effect of pressure on sprinkler performance.

J. P. Schaenzer, chairman of textbook entries, reported that an unusually fine group of 75 recently-published textbooks were displayed. No awards were given in this class.


W. W. HENNING


J. ROBERTS


J. H. OLIVER

W. W. Henning of International Harvester Co. has been promoted to the position of manager of engineering in the company's farm equipment group. He formerly held the position of manager of engineering for the farm tractor division. His new position places him in charge of all engineering activities in the company's farm equipment group, comprised of the farm tractor and farm implement divisions and the farm equipment sales division.

Mr. Henning joined the company in 1935 as a draftsman at the McCormick Works in Chicago after graduation from Armour Institute of Technology. After serving in various engineering capacities in the company's farm tractor and construction equipment divisions, he was named manager of engineering of the farm tractor division in 1957, and served in that capacity until the time of his new appointment.

Hiram P. Smith, an employee of International Harvester Co. since 1930, has been appointed to the position of an assistant manager of engineering, farm equipment group. Mr. Smith who has held several responsible positions with the company served as manager of engineering in the farm implement division before his new appointment.

J. Roberts will be associated with the research and engineering department of the John Deere Harvester Works at East Moline, Ill., during a sabbatical leave from his position as chairman of the agricultural engineering department, State College of Washington.

James H. Oliver recently retired after 35 years with General Electric Co., has accepted the position of sales promotion manager in charge of preparation of application information for Aerovent Fan and Equipment, Inc., of Lansing, Mich. He is a native of Canada and earned a B.S. degree in electrical engineering from McGill University in Montreal. His work with the General Electric Co. was in the field of farm electrification with their apparatus sales division.

In addition to his duties with Aerovent, where he will continue to promote crop drying and ventilation use, he will serve on the Farm Equipment and Structures Research Advisory Committee for the Secretary of Agriculture.


D. D. REED


J. E. COLLINS

Dale D. Reed, who has previously served as representative for the LeTourneau-Westinghouse Co. government sales department at Washington, D.C., has been appointed the company's special government sales representative for Canada. The purpose of this new post is to expand service to the Canadian government in matters of consultation on government contracts, sales and technical problems. Mr. Reed will also represent J. D. Adams Co., Ltd. of Paris, Ontario, the firm's Canadian subsidiary, in matters relative to government sales. He has also been a member of the company's field engineering department. Before joining the firm in 1956 he served in the U.S. Army, Corps of Engineers as a project officer in charge of testing aviation engineering construction equipment. He received a B.S. degree in agricultural engineering from Purdue University in 1953.

Joseph E. Collins has been promoted to senior agricultural sales engineer of the Appalachian Electric Power Co. with headquarters in the company's System Commercial Department at Roanoke, Va.

From 1940 to 1942, and after his graduation from Virginia Polytechnic Institute, he was employed with Shenendoah Valley Electric Coop. as rural electrification advisor and utilization specialist, promoting the use of electricity on the farm by method and result demonstrations. In 1942 he accepted a position with the Glen L. Martin Co., Baltimore, Md., where he was employed as first class ground and flight test inspector. He returned to VPI in 1945 to accept a position in connection with the Virginia Agricultural Extension Service. He first joined the staff at Appalachian Electric Power Co. in 1949 where, in 1950, he became rural and residential sales supervisor at Abington, and in 1957, was named electrical engineer. He earned an M.S. degree from VPI in 1955.

H. E. McLeod has returned to Clemson Agricultural College, Clemson, South Carolina, as assistant professor of agricultural engineering, after a three-year leave of absence for study at Iowa State College. He now holds an M.S. degree in agricultural engineering and has earned credit toward a Ph.D. degree.

Accept AE Department Head Appointments


D. T. KINARD


R. L. GREEN

Announcements have been received that agricultural engineering department heads have been appointed at the University of Florida and University of Maryland.

Drayton T. Kinard, newly appointed head of the agricultural engineering department at the University of Florida, assumed his duties August 16. Dr. Kinard who formerly headed the agricultural engineering department at the University of Kentucky was born in Dillon, S. C., and received a B.S. degree in agricultural engineering at Clemson College. He graduated from Virginia Polytechnic Institute with an M.S. degree and later earned a Ph.D. degree from Michigan State University.

In 1941 Dr. Kinard joined the University of Georgia staff as a research associate and was promoted to professor of agricultural engineering in 1955. In 1956 he was named head of the newly formed agricultural engineering department at the University of Kentucky where he continued until he accepted the invitation to join the staff at the University of Florida as successor to the late Frazier Rogers.

In addition to his teaching experience, he worked for several commercial firms as well as the Farm Security Administration and the U.S. Soil Conservation Service. He served four years in the Army during World War II, with two years spent in the European Theater.

Robert L. Green has accepted the position of head of the agricultural engineering department at the University of Maryland where his departmental duties will include the supervision and coordination of agricultural engineering activities in teaching, research and extension. Dr. Green received a BSAE degree from the University of Georgia, an M.S. degree from Iowa State College, and a Ph.D. degree from Michigan State University.

From 1934 to 1947 he was with the Soil Conservation Service in Georgia, with five years of this time being spent in the service of the U.S. Army. Among other professional appointments, he has been employed as assistant professor of agricultural engineering at Louisiana State University and for two years served as agricultural engineer with the U.S. Special Technical and Economic Mission for Indonesia. Before his present assignment he was superintendent and agricultural engineer of the Southeastern Tidewater Experiment Station, Soil and Water Conservation Research Division, ARS, USDA in Fleming, Georgia.

R. W. JONES

D. R. BURROWBRIDGE

R. W. Jones retired October 1 from his position as watershed specialist with the Soil Conservation Service, U.S. Department of Agriculture. He was born in Pisgah, Iowa, in 1899.

Previous to receiving his Civil Service rating in 1935, Mr. Jones was engaged in the investigation of highway traffic in Iowa, acting as special investigator for the Secretary of State. Later he became assistant director of ECW, Iowa, in connection with the USDA.

In 1935 he was named engineer inspector for the Soil Conservation Service located in Bethany, Mo. He accepted the position of project superintendent with the Iowa SCS No. 12 at Moorhead, Iowa, in 1936, and while serving in this capacity received national citation for his activities as director of the safety program. He also directed and supervised drag-lines, tractors and heavy earth moving equipment used in constructing large earth dams and developed complete conservation plans on 300 farms.

As soil conservationist of Mills County Conservation District, Malvern, Iowa, a position he accepted in 1941, he directed the planning and establishment of all conservation practices with farmer cooperators and developed field methods for operating various types of equipment in conservation practices.

In 1957 he received the U.S. Department of Agriculture Superior Service Award for his watershed accomplishments. As early as 1935 he advocated the formation of small, farmer cooperative watershed projects. As one of the first advocates of farm plans based upon the capability of the soil, with supporting conservation practices to control run-off and reduce soil loss, he is often referred to in Iowa as the Father of Level Terraces.

Mr. Jones plans to limit his professional activity to conservation consulting, appraisal and management.

D. R. Burrowbridge who has previously been employed as director of Thor Research Center in Marengo, Ill., has accepted a position with Virginia Polytechnic Institute, Blacksburg, Va., where he will serve as coordinator for the Farm and Home Electrification Council. In his new assignment he will be responsible for planning and organizing in-service training programs for professional agricultural workers and coordinating the council's state wide program in farm and home electrification.

Joe R. Jones has accepted a position with the Texas Technological College, Lubbock, Texas, where he will be an instructor in the agricultural engineering department. Along with other teaching responsibilities he will instruct the gin engineering course, which, he reports, is the only undergraduate course of its nature being taught. Mr. Jones was formerly employed as assistant agricultural engineer, cotton ginning, at the A & M College of Texas.

Harold E. Gray who has been connected with the agricultural engineering department of Cornell University has become director of sales promotion and development for Lord & Burnham, Division of Burnham Corporation at Irvington-on-Hudson, N. Y. He recently spent 18 months in the Philippines where he served on the staff of the Cornell-Los Banos project with the College of Agriculture of the University of the Philippines.

G. H. Dunkelberg has returned to Clemson Agricultural College, Clemson, South Carolina, after a two-year assignment at the Indian Institute of Technology, Kharagpur, India. While in India he was employed as a member of the staff of the agricultural engineering department of the University of Illinois under their contract with the International Cooperation Administration.

Roger Yoerger, formerly associated with the agricultural engineering department of Pennsylvania State University, has joined the staff of the University of Illinois July 1 with primary responsibilities in the power and machinery area.

ASAE MEETINGS CALENDAR

October 16 — CENTRAL ILLINOIS SECTION, Caterpillar Building, Peoria, Ill.

October 16-17 — PENNSYLVANIA SECTION, Abraham Lincoln Hotel, Reading, Pa.

October 17-18 — OHIO SECTION, Ohio State University, Columbus, Ohio

October 22-25 — PACIFIC NORTHWEST SECTION, Oregon State College, Corvallis, Ore.

October 24 — GEORGIA SECTION, Athens, Ga.

October 24 — IOWA SECTION, Latin King Restaurant, Des Moines, Iowa

October 24-25 — ALABAMA SECTION, Alabama Polytechnic Institute, Auburn, Ala.

October 27 — MINNESOTA SECTION, Minneapolis Campus, University of Minnesota, Minneapolis, Minn.

October 30-31—SOUTH CAROLINA SECTION, Clemson Agricultural College, Clemson, S. C.

November 14 — OKLAHOMA SECTION, Oklahoma State University, Stillwater, Okla.

(Continued on page 669)

Three Elected to Grade of Fellow

Mack M. Jones, Irwin L. Saveson and **David S. Weaver** were recently awarded the grade of Fellow by the Council of ASAE for distinctive services in the field of agricultural engineering.

Mack M. Jones, a member of the Society since 1919, was born in Edgerton, Mo., October 8, 1896. He received a B.S. degree in electrical engineering in 1918 from the University of Illinois and an M.S. degree in agricultural engineering from Iowa State College in 1927.

During World War I he served in the U.S. Army Signal Corps. Following army service he became an instructor in agricultural engineering at Texas A. & M. College until September 1919 when he joined the agricultural engineering staff at the University of Missouri as instructor in farm machinery, engines, tractors, and farm shop practice, becoming chairman of the department in 1948.

He assisted in the organization of three ASAE Sections — North Central Section, Missouri Section, and the Mid-Central Section — and held major offices in each.

Mr. Jones is well respected for his professional accomplishments and has authored several widely used textbooks on farm shop work and a number of bulletins of the Missouri Agricultural Experiment Station. He is active in the Christian Church and in work with the Boy Scouts and Campfire Girls.

Irwin L. Saveson was born June 28, 1900, in Columbus, Ohio. In 1922 he received a B.S. degree from the Ohio State University with a major in agricultural engineering. The University awarded him an Honorary Professional Engineering degree in 1952.

From 1922-1933 Mr. Saveson was in the business of farm equipment and contracting. In 1933 he joined the U.S. Department of Agriculture where he worked on drainage and erosion control in Ohio and Indiana with the Operation Division of the Soil Conservation Service.

He is considered a prominent figure in development of land forming in the humid areas of the United States, his efforts resulting in important developments in the solving of farm land drainage problems. His work with the Research Division in Louisiana where he was transferred in 1944 attracted world-wide attention. In 1952 the project work there was extended to the cotton section and included both drainage research and deep tillage research in cotton and sugar cane. Currently this project under his supervision is set up to cover the drainage problems of the Mississippi Delta section of Arkansas, Louisiana and Mississippi and is operated under the Soil and Water Conservation Research Division of the Agricultural Research Service, U.S. Department of Agriculture. Mr. Saveson is the author of several publications on surface drainage and deep tillage.

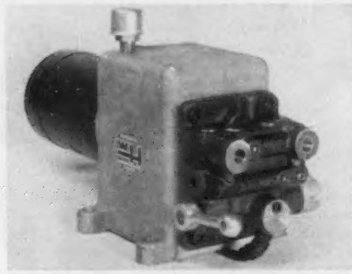
Among his engineering accomplishments is the development of a direct mounted, hydraulically controlled mole drain machine, for which a public service patent was issued. He was awarded the USDA Superior Service Award for his work in drainage of sugar cane land in 1950.

David S. Weaver was born in Westwood, Ohio, June 19, 1896, and received his B.S. degree in 1920 from Ohio State University. Following his graduation he remained at the University for three years, assisting in the agricultural engineering department. He was then called to Mississippi A & M College where he became assistant professor of agricultural engineering. In 1923 he accepted a position in the agricultural engineering department at North Carolina State College where he was associate professor and from where he received an M.S. degree in agricultural engineering in 1925. He became head of the agricultural engineering department in 1940, serving in this capacity until 1948 when he was promoted to assistant director of the North Carolina Agricultural Extension Service, later becoming director, the position he now holds. On a leave of absence from 1936-1937 he joined the Federal Rural Electrification Administration as principal engineer.

Mr. Weaver is a pioneer as well as a national figure in the development of rural electrification, conducting the nation's first statewide survey in this field. He has also been a leader in the mechanization of cotton and tobacco and the introduction of irrigation in the South Atlantic states.

New Hydraulic Power Unit

Wisconsin Hydraulics, Inc., announces a new hydraulic-power unit (Model 620) featuring a 4-way control valve for precise control of any double-acting cylinder. The compact, completely integral unit, consisting of 6 or 12-volt d-c motor drive, pump, 4-way control valve and tank is controlled by a single lever that can accommodate a clevis for remote-control linkage. There are three



operating positions including spring return to neutral, with positive checking of oil ports in the neutral position. The 110-cu-in. rectangular oil reservoir is made of cast aluminum. The electric motor is flange-mounted to one end of the housing, and the 4-way control valve to the other. Working parts are totally enclosed for all-weather protection. The power unit may be mounted vertically, with motor end up, or horizontally.

(For more facts circle No. 51 on reply card)

New Irrigation Sprinkler

Rain Bird Sprinkler Manufacturing Corp. announces a new series of irrigation sprinklers (Model No. 29). The top seal of this sprinkler consists of a specially formed, saucer-shaped teflon washer, sealing against the bearing nipple and sleeve, and is held in place by a brass washer and upthrust

spring. The bottom seal consists of an L-type teflon insert ring and soft neoprene washer. All bearing wear is on this replaceable washer and ring. This new series of sprinklers are of the single-nozzle, full-circle, slow-rotating type and have bridge-type protective construction of body designed to provide balanced, two-point drive and reduced wear on all moving parts.

(For more facts circle No. 52 on reply card)

PTO Drive for Forage or Grain Blower

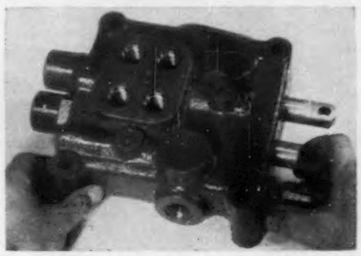
Allis-Chalmers Mfg. Co. announces a power take-off drive for its forage and grain blower which will fit any of the company's blowers and permits driving from either side. The PTO attachment can be quickly and easily hooked up in close quarters. The drive is through an enclosed gear box

and triple V-belt sheaves which cushion shock loads and protect both tractor and blower. Varying fan speeds are made possible for reversing the V-belt sheaves for grain and other crops. A spring-loaded idler maintains proper belt tension for longer life and less need for belt adjustment. The unit is shielded for safety.

(For more facts circle No. 53 on reply card)

Hydraulic Directional Valves

Wooster Division, Borg-Warner Corp., announces a new line of directional control valves designed to meet the stringent requirements of hydraulic oil systems on earth-moving, materials-handling agricultural and industrial equipment. The new line offers nominal ratings from 5 to 25 gpm and up to 6-spool configuration. These new valves

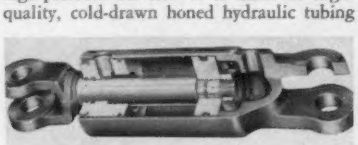


are designed for operating pressures up to 2000 psi. The open-center, parallel-circuit design of these valves permits independent or simultaneous operation of cylinders or hydraulic motors. In addition, multiple cylinders and hydraulic motors can be operated from a single multispool valve. Actuation of the valves is through a lever control.

(For more facts circle No. 55 on reply card)

Hydraulic Cylinders

Densmore Engineering Co. is offering a hydraulic cylinder designed for medium high-pressure service. It is made of high-quality, cold-drawn honed hydraulic tubing

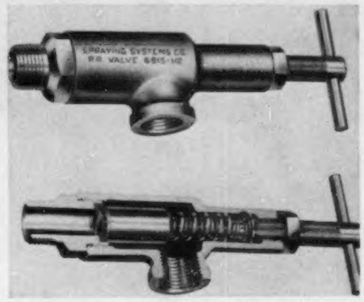


pressure tested for 1000-psi service. The gland and piston are of aluminum alloy and the piston rod is chrome plated. The base and rod clevises are cast steel electric welded to the barrel and conform to ASAE standards.

(For more facts circle No. 54 on reply card)

Pressure-Relief Valve for Spraying

Spraying Systems Co. announces a new pressure-relief valve which is made with hardened stainless steel parts for maximum wear resistance to liquids containing abrasive suspended solids, sometimes contained in chemicals used in farm spraying. In the new pressure-relief valve, the valve guide and inlet adapter are fitted with hardened stainless steel inserts to provide a high degree of resistance to abrasive wear. The re-

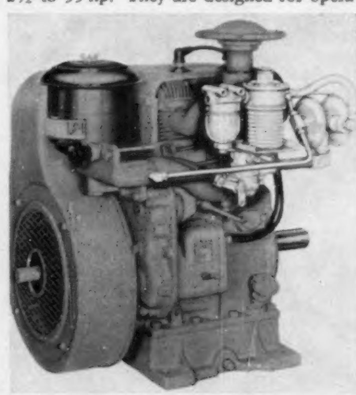


mainder of the unit is made of brass with stainless steel springs. Two springs with different tensions are provided, the lighter spring controlling low-pressure settings and the heavier spring controlling higher pressure settings. Dual springs are used to provide extra sensitivity to over-all pressure adjustment range up to 300 psi. Other design features include an extra large valve passage for handling full flow from supply line to the ¾-in. pipe size and pressure setting lock that will not loosen under jar of rig operation.

(For more facts circle No. 56 on reply card)

LPG Air-Cooled Engines

Wisconsin Motor Corp. announces a complete line of heavy-duty air-cooled engines specially designed for operation on liquid petroleum fuels (butane, propane, or a mixture of both). This line of engines includes a full range of sizes from single-cylinder models to two-cylinder and V-type four-cylinder models in a complete range from 2½ to 55 hp. They are designed for opera-



tion either with a liquid-withdrawal or vapor-withdrawal system. The company can supply LPG conversion kits for converting its standard gasoline engines to LPG operation. The LPG line is not intended to replace the regular line of Wisconsin engines, but is being made available as an additional line to meet the demand for this type of engine.

(For more facts circle No. 57 on reply card)

(Continued on page 660)

Spiral Bevel....
Hypoid Bevel...
Zerol Bevel.....*
Straight Bevel...
Coniflex Bevel...*
Flywheel Ring Gears..........
Straight Spur.....
Spur & Helical...
Spline Shafts......
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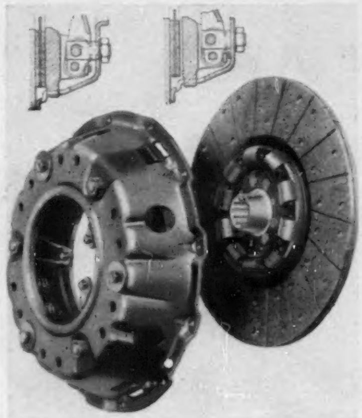
(For more facts circle No. 37 on reply card)

. . . New Products

(Continued from page 658)

Spring-Loaded Clutch Assembly

Rockford Clutch Div., Borg-Warner Corp., has patented a new design and arrangement of levers for operating spring-loaded clutch assemblies. Use of a rolling-fulcrum pin action in the release lever is said to result in less friction and wear, as well as smoother release operation. The



levers automatically return to their original position after full engagement of the clutch. Also the levers are carefully balanced to avoid lever throwout at high engine speeds. The clutch automatically compensates for facing wear. The clutch-driven member is offered with solid or dampener arrangement, the latter for dampening out torsional vibration noises. A cushion feature is also available for promoting smoother engagement.

(For more facts circle No. 58 on reply card)

Spreader Used as Power-Unloading Wagon

New Idea Farm Equipment Co. offers a new PTO 125-bushel spreader designed to quickly adapt the unit for use as a power-unloading wagon. It is available in two separate add-on units. The spreader is equipped with forage sides to provide a capacity up to 205 cu ft. The first unit, comprised of rear-end assembly and steel sides

21½ in. high, gives a capacity of 150 cu ft, and the second unit of 15½ in. high forage side extension gives an additional 55-cu ft capacity. A tray-type steel feed gate at the rear can be operated by one man. The distributor paddles are removed from the spreader when the forage sides are added. When the main cylinder is used, five feed speeds are available. A single fast-unloading speed is available when the bed conveyor is used for cleanout.

(For more facts circle No. 59 on reply card)

New Line of Agricultural Tractors

John Deere has introduced a new line of agricultural tractors designated as the "30" series, which are available in six power sizes and 30 basic models, ranging from 1 to 2-plow to 6-plow units. In addition to their

new styling, these new tractors feature advanced power steering, a versatile hydraulic system, three-point hitch with load-depth control, live power shaft, and the float-ride seat which have been carried over from previous models.

(For more facts circle No. 60 on reply card)

Pillow Block Ball Bearing

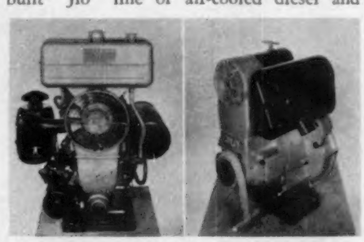
The Fafnir Bearing Co. has introduced a new standard series LAKH pillow block ball bearing designed to meet specific requirements for varying over-all dimensions. Similar in design and load capacities to other standard series Fafnir pillow blocks, the

LAKH features a wide inner-ring ball bearing incorporating a mechanical seal. Said to be frictionless and wearless, this seal is an integral part of the bearing which keeps lubricants in and foreign matter out. The bearing is self-aligning and can be installed quickly.

(For more facts circle No. 61 on reply card)

Air-Cooled Diesel and Gasoline Engines

Hercules Motors Corp. has acquired sole American distribution rights to the German-built "Jlo" line of air-cooled diesel and



gasoline industrial engines within the United States. The gasoline engines range from 1 to 33 hp. The diesels are offered in two basic models—7 and 12 hp and weigh 110 and 190 lb, respectively.

(For more facts circle No. 62 on reply card)

(Continued on page 662)

. . . New Products

(Continued from page 660)

New Tractor Line

International Harvester Co. has recently released a new line of 12 Farmall and International wheel tractors in six power sizes at the company's Hinsdale, Illinois, experimental farm. Dazzling lights, full bands, and special entertainment heralded in the new tractors and equipment during

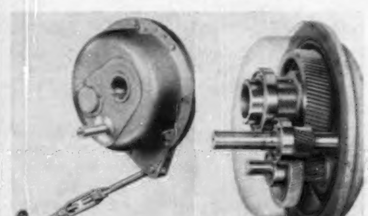
seven two-day, and three one-day shows put on by a cast of 110 using 260 tractors and approximately 200 other pieces of farm and industrial equipment. Over 11,000 people attended the introduction, of which nearly 8,500 were dealers and sales personnel from every part of the United States and Canada.

The new line of tractors is in keeping with the trend towards greater capacity and more productive operations both on the farm and in industry. There are 6-cylinder engines on the larger tractors; advanced styling; increased power in most models; special new operating features; a wider selection of gasoline, LP Gas, distillate, or diesel engines, and new power steering on more models than ever before. A new 3-point hitch with Traction-Control is now available for 2 and 3-plow tractors.

(For more facts circle No. 77 on reply card)

Shaft-Mounted Speed Reducers

Link-Belt Company has introduced a completely new line of shaft-mounted speed reducers, designed for a great variety of speed-reduction needs. The new units are available as (1) single-reduction drives in six sizes with nominal ratios of 5 to 1 and capacities up to 50 hp, and (2) double-



reduction drives in seven sizes with nominal ratios of 15 to 1 and capacities up to 40 hp. These speed reducers can be mounted at angular as well as horizontal positions by either tie rod or foot mountings. Positive lubrication is constantly assured by live-action oil spray generated automatically through gear rotation, regardless of the position in which the reducer is mounted. Precision housings and bearing seals keep oil in and dirt out. A new 24-page book (No. 2618) describing this new line of shaft-mounted speed reducers is available.

(For more facts circle No. 78 on reply card)

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4	14	24	34	44	54	64	74	84	94
5	15	25	35	45	55	65	75	85	95
6	16	26	36	46	56	66	76	86	96
7	17	27	37	47	57	67	77	87	97
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5	15	25	35	45	55	65	75	85	95
6	16	26	36	46	56	66	76	86	96
7	17	27	37	47	57	67	77	87	97
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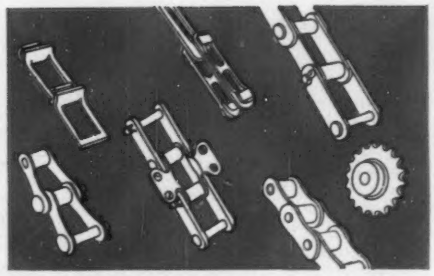

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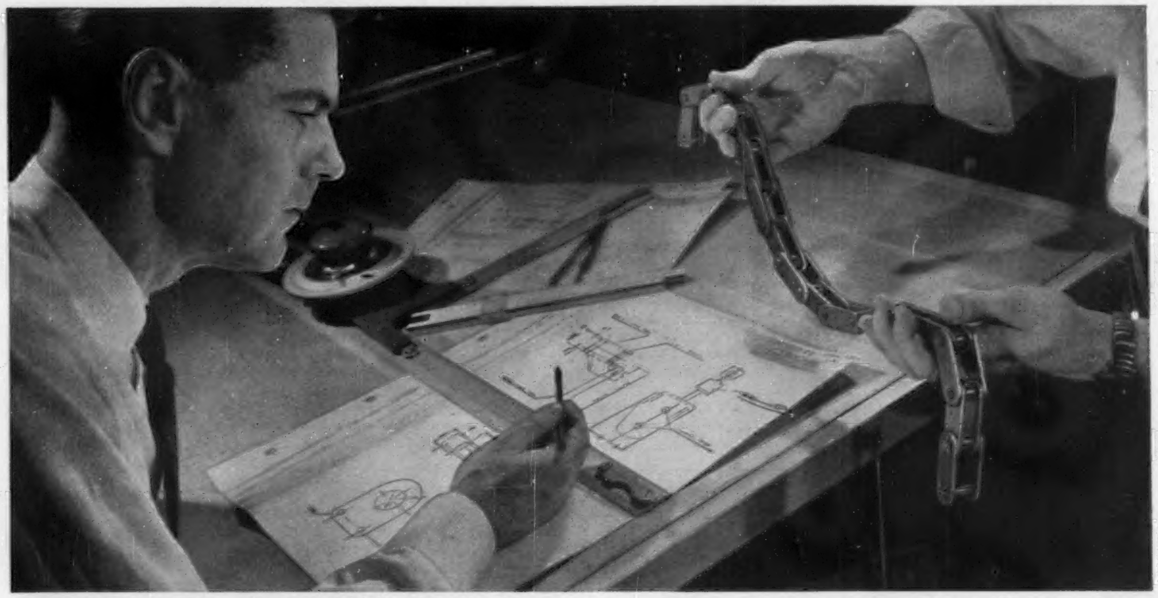

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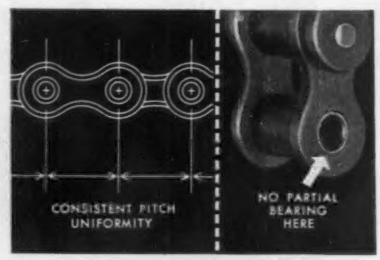
4. LABORATORY SERVICE — Every Link-Belt chain meets rigid uniformity specifications. And our laboratory, located at the world's largest plant manufacturing drive and conveyor chains, continuously seeks new ways to increase chain life.

5. BETTER DESIGN AND MANUFACTURE — Precision manufacture and close processing control assure consistent quality and unvarying pitch uniformity in every link, every time. Also, consistency of press fits adds to life of all Link-Belt roller chain. Lock-type bushings, which end a cause of stiff chain, are typical of design bonuses.



For facts on Link-Belt's complete line of chains, sprockets and attachments, contact your nearest Link-Belt office.

LINK-BELT

THE SYMBOL OF QUALITY LINK-BELT

CHAINS AND SPROCKETS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs. Representatives Throughout the World. 14,900

(For more facts circle No. 44 on reply card)

. . . Technical Paper Abstracts

(Continued from page 653)

Development of the Passion Fruit Centrifuge, by D. M. Kinch, head, agricultural engineering department, University of Hawaii. Presented at the Annual Meeting of ASAE at Santa Barbara, Calif., June 1958, on a program arranged by the Electric Power and Processing Division. Paper No. **58-117.**

The operations of processing passion fruit to obtain the juice are outlined in this paper. The slicing operation is touched on as it pertains to extraction, and the operation of extracting the juice and seed sacs from the rind is discussed in some detail. The development of a continuous-process non-fluid centrifugal extractor to perform this function is described.

The design requirements for such an extractor are developed from the basic concepts of centrifugal force and coefficient of friction between passion fruit rinds and stainless steel. The paper further discusses the experimental methods by which these basic principles were applied and embodied in a successful centrifugal juice extractor.

Artificial Methods of Ground Water Recharge, by Meyer Kramsky, principal hydraulic engineer, California Department of Water Resources, Sacramento, Calif. Presented at the Annual Meeting of ASAE at Santa Barbara, Calif., June 1958, on a program arranged by the Soil and Water Division. Paper No. **PL58-6.**

This paper briefly outlines the characteristics of ground water reservoirs and describes artificial recharge techniques as related to the use of stream bed percolation, flooding, basins, the ditch and furrow method, and the more limited method of the diversion of water into pits, shafts or injection wells. A summary is presented of artificial recharge activities in the state of California which derives about twelve million acre-feet per year, more than one-half its entire water supply, from ground waters.

Control of Slides by Underdrainage, by A. W. Root, supervising materials and research engineer, California Division of Highways. Presented at the Annual Meeting of ASAE at Santa Barbara, Calif., June 1958, on a program arranged by the Soil and Water Division. Paper No. **PL58-15.**

In the discussion of ground water as the major single factor in causing land slides, the author reviews several methods of subdrainage used to prevent a rise in ground water level. Methods evaluated in the paper include intercepting drain trenches, stabilization trenches, drainage tunnels, horizontal drains, and vertical sand drains. Drawings are used to illustrate drainage methods described.

Performance of Flood Prevention Works During 1957 Spring Floods, by Howard Matson, head, engineering and watershed planning unit, (SCS), USDA. Presented at the Annual Meeting of ASAE at Santa Barbara, Calif., June 1958, on a program arranged by the Soil and Water Division. Paper No. **58-151.**

This paper describes the performance of watershed protection and flood prevention works of the Soil Conservation Service in Arkansas, Oklahoma and Texas during the severe storms and floods of April, May and June, 1957. Excessive rainfall began April 19 and continued through most of June. From 35 to 40 in. were recorded at several points. The mean depth recorded over the three states was 19 in., amounting to 445 million acre-feet. The maximum 2-day rainfall was 22.4 in.

The paper states that the completed flood prevention works prevented $2,162,000 in flood damages and that if all feasible tributary watershed flood prevention work had been completed 33 million acre-feet of detention storage would have been available to control 62 million acre-feet of floodwater. The author also states that a total of $109,320,000 of flood damages would have been prevented, a reduction of 70 percent, and there would have been no loss of lives in creek floods. He believes that the adequacy and safety of the structure designs were evidenced by the fact that no structures were in danger of failure as a result of these intense successive storms.

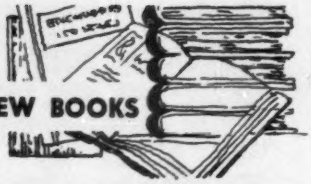
Correction and Addition

Word has been received from W. E. Matson that the following active projects at State College of Washington should be added to the list of Current Research Activities in Feed Handling in the United States and Canada, September issue, page 582:

Project 1177 — The Development of Self-Feeding Silo, 1950 to 1959, Donald Backus and June Roberts in charge.

Project 1357 — Materials Handling on Poultry and Dairy Farms, 1950 to 1960, W. E. Matson and Clifford Zuroske in charge.

Project 1424 — Labor and Machinery Requirements for Various Green Forage Harvesting Methods, M. J. Morgan and J. Swanson in charge. Projects 1177 and 1357 are in cooperation with the Washington Farm Electrification Committee and progress reports are available. Progress reports of Project 1424 are not presently available.



Atomic Energy in Agriculture, by William E. Dick, B.Sc., F.L.S. Cloth, 5½ x 7½ inches, x + 150 pages, illustrated and indexed. Published by Philosophical Library Inc., 15 East 40th St., New York 16, N. Y. $6.00.

The subject material of this book is taken from accounts of discoveries relevant to agricultural progress contained in papers delivered at Geneva in August 1955 during the international conference on the peaceful uses of atomic energy, and deals with current scientific research in that field. It includes information on research in radiation mutations and relates possibilities included in the use of atomic radiation in food preservation and pest control. The author also devotes one chapter to radio-isotope work which he states is of immediate practical consequence in forestry.

Forest Soils, by S. A. Wilde. Cloth, 6 x 8 inches, xii + 537 pages, illustrated and indexed. Published by The Ronald Press Co., 15 East 26th St., New York 10, N. Y.

This publication was written to be used as a textbook to meet the requirements of students of forestry and soils, and for the service of specialists engaged in utilization of forest lands. Particular attention is given to maintenance of nursery soil fertility, survey of forest lands and selection of planting sites, diagnosis of adverse conditions responsible for poor growth of trees, application of fertilizers, detection and evaluation of changes produced in the composition of the soil by different silvicultural treatments, and correlation of forest management with the productive potential of forest lands.

The Law of Water Allocation in the Eastern United States, edited by David Haber and Stephen W. Bergen. Paper cover, 6 x 9 inches, xxxviii + 643 pages, indexed. Published by The Ronald Press Co., 15 East 26th St., New York 10, N. Y. $7.50.

This publication contains papers and proceedings of a symposium held in Washington, D. C., October, 1956, sponsored by the Conservation Foundation. It reports on national ground water resources, industrial water use, the role of vegetation in watershed management, the ocean as a possible fresh water source, and the merits of various methods of flood control. It is intended for those who are concerned with questions of state water rights legislation and water allocation policy. In particular, it is for investigators and legislators who are seeking means of adapting existing water laws to changing patterns of water use.

Proceedings of Sixth Annual National Dairy Engineering Conference, sponsored by the Department of Agricultural Engineering with the cooperation of the Department of Dairy and the Continuing Education Service, Michigan State University held February, 1958. Paper cover, 11¾ x 8½ inches, 113 pages, indexed. $2.00.

This compilation contains papers presented around the following topics: putting electronics to work in the dairy plant, automatic cleaning equipment and methods, milk meter developments, and improving plant operations. Titles of the papers are: basic research in industry, using electronic equipment in computing dairy problems, digital computer, how automation applies to your dairy, applications for automatic cleaning, automatic control for cleaned-in-place, the Siemen's sanitary flow meter, the B & R oval wheel meter, the Pottermeter, the accuracy of a milk metering device, electromagnetic metering of milk flow, the Sharples sanitary flow-meter, the Micro-Meter, air agitation of milk, engineering problems in using wax in packaging operations, keeping dairy engineering records, engineering for a five or a four day dairy plant operation, refrigeration losses through open doors and conveyor passes, developments in dairy waste disposal, plastic coated containers for milk and milk products, and the new look in dairy plant layout.

Concentrated Spray Equipment Mixtures and Applications Methods, by Samuel Frederick Potts. Cloth, 6 x 9¼ inches, xxxiii + 598 pages, indexed and illustrated. Published by Dorland Books, P.O. Box 31, Caldwell, N. J. $12.50.

Text of this book includes information on subjects which cover diverse phases of agricultural chemicals application equipment and the agriculture to which they apply. It gives information on concentrated spray applications of insecticides, fungicides, hormones, herbicides, silvicides, nutrients, fertilizers, and insect disease organisms. Chapters cover terminology, fundamentals of application, ground spray equipment, aerial equipment, mixtures, control of weeds and woody plants, aerosols, and determining particle size of aerosols and fine sprays.

MANUFACTURERS' LITERATURE

Equipment Catalog

Allis-Chalmers Mfg. Co.—A 12-page catalog, "New Design . . ." (TL-1878) is a pictorial review of the company's tractors, harvesting equipment, implements and other farm machinery.

(For more facts circle No. 76 on reply card)

Hog Housing Plans

Douglas Fir Plywood Ass'n — Four booklets contain 4 series of plans for farrowing building, growing building, finishing building and hog trailer.

(For more facts circle No. 75 on reply card)

Flexible Cushion Couplings

Dodge Mfg. Corp. — A 12-page bulletin A669 which describes the company's flexible cushion coupling. Photographs and drawings illustrate construction and installation features of the product. Also included are tables with engineering data to facilitate selection of couplings.

(For more facts circle No. 74 on reply card)

Flexible Couplings

T. B. Wood's Son's Co. — An 8-page bulletin No. 10100 which describes the line of flexible couplings manufactured by the company. The patented flexible coupling consists of two flanges and a two-piece rubber sleeve, which lock together without clamps or screws.

(For more facts circle No. 73 on reply card)

Land Forming Equipment

Gurries Mfg. Co. — Booklet 107 introduces the company's line of land forming equipment and features a field planer with its planing action described in detail. The company's levelers and new 5.0 cu yd hydraulic scraper are also described.

(For more facts circle No. 70 on reply card)

Clearing Blade

Rome Plow Co. — A 6-page booklet describing the new K/G clearing blade for shearing trees and windrows. The clearing blade is designed to take out both large and small trees including stumps and roots and pile them in compact windrows.

(For more facts circle No. 71 on reply card)

Fuel Oil and High-RPM Diesels

Detroit Diesel Engine, Div. of General Motors Corp. — A 16-page illustrated booklet which points out the effects of various grades of fuel on diesel engine life and performance. It also includes a fuel selection chart to assist operators in selecting the type of fuel that will result in the most satisfactory operation.

(For more facts circle No. 66 on reply card)

Specialty Steels

Crucible Steel Co. of America—A 12-page brochure discussing various grades of steels for heavy construction and mining, including alloy, carbon, drill, stainless and tool steels. Recommended technical manuals and aids are also depicted and described.

(For more facts circle No. 64 on reply card)

Flexible Tubing Data Book

Pennsylvania Flexible Metallic Tubing Co. — A 36-page booklet which covers all types of flexible tubing and hose, together with many types of couplings which can be used with tubing. A step-by-step instruction page is included to assist the engineer or purchasing agent in ordering flexible tubing.

(For more facts circle No. 65 on reply card)

100 Years of Progress

Twin Disc Clutch Co.—A 24-page magazine, Production Road, Vol. 19, No. 4, features an article covering 100 years of progress on the American agricultural scene. The story describes the progress of farm machinery and equipment from the advent of the steel plow with facts on social and economic changes within the past 100 years of agriculture.

(For more facts circle No. 67 on reply card)

Building With Wood

National Lumber Mfrs. Ass'n — A 34-page bulletin, Better Homes are Built of Wood, includes over 50 photographs and drawings showing the use of wood to improve the appearance, increase the livability and raise the value of old and new homes.

(For more facts circle No. 69 on reply card)

Recording Soil Tester

Soiltest, Inc. — An illustrated bulletin entitled Unconfined Clay Compression Test Machine. The machine was developed in Great Britain and is said to include a recording system that provides a permanent record of all tests performed.

(For more facts circle No. 68 on reply card)

Tire Handbook

B. F. Goodrich Tire Co. — A 52-page booklet describes how equipment and owners can get maximum service out of off-the-road tires. Factors in off-the-road tires including load, inflation, operating conditions and tire care are discussed.

(For more facts circle No. 72 on reply card)

Chicago Section

The Annual Meeting of the Chicago Section was held September 8 in the assembly room of the manufacturing research plant of the International Harvester Co. The 100 members and guests present toured the company's Manufacturing Research Division prior to the business meeting and were invited to be guests of International Harvester Co. for lunch.

The new officers elected are: chairman, K. V. D. Fiske, National Safety Council; secretary-treasurer, Tobi Goldoftas, International Harvester Co.; publicity vice-chairman, T. E. Clague, Aubrey, Finlay, Marley and Hodgson; program vice-chairman, H. J. Brethauer, Martin Implement Co.; and outstate vice-chairman, J. H. Ebbinghaus, A. O. Smith Corp.

Following the business meeting, P. L. May of International Harvester Co., Memphis Works, reported on the company's newly created hay pelletizer and showed motion pictures describing it to its present stage of development.

Iowa Section

The date for the Iowa Section Meeting has been set for October 24, to be held at the Latin King Restaurant in Des Moines. The program will feature Edgar Urevig, manager of the Tilney Farms in Louisville, Minn., who will discuss agricultural engineering advances and their application to efficient farm operations.

Central Illinois Section

The Central Illinois Section Meeting is to be held October 16 at the Caterpillar Building in Peoria. "The Unusual Applications of Agricultural Engineering" is the title of the presentation to be given by E. J. Stirniman who is a consultant with the Caterpillar Tractor Co., Peoria.

Ohio Section

The fall meeting of the Ohio Section will be held October 17-18 at Ohio State University.

Two papers on materials handling, one by S. S. DeForest and a second by J. D. Blickle and Kenneth Battles will introduce the Friday afternoon session. Following the business meeting Earl Haller and C. E. Smith will discuss phases of flood control and drainage.

The banquet, to be held at the student union, will feature Ferris Owen who will speak on recent trends in agriculture in the Soviet Union.

Quality forage will be the theme of the Saturday morning session with papers presented by D. O. Hull, E. A. Silver, and Wm. Tyznik. The concluding presentation will be a progress report on forage harvesting method study, by S. R. Anderson and K. A. Harkness. A football game between Ohio State and Indiana will be held Saturday afternoon.

. . . Meetings Calendar

(Continued from page 657)

April 16-18 — FLORIDA SECTION, George Washington Hotel, West Palm Beach, Fla.

December 17-19 — WINTER MEETING, Palmer House, Chicago, Ill.

. . . How Efficient?

(Continued from page 652)

highly organized data can become a sort of new dimension in engineering.

To a large extent farm machines must be engineered for more than "normal" use. They must be designed against a certain amount of negligence and abuse in operation and against widely changing operating conditions. The following opinion is quoted from a recent letter by one agricultural engineer who is an authority on farm machine operation:

1 Tractors: Time out is remaining constant or possibly decreasing, due to *(a)* better design, *(b)* better trained operators, *(c)* better fuels and lubricants.

2 Other Machines, particularly harvesting machines: Time out increasing due to *(a)* more complicated machines, *(b)* higher speeds, *(c)* higher yielding crops, *(d)* operators not "keeping up" with complexity of machines, *(e)* crowding marginal weather and soil conditions more.

3 Tillage Machines: Higher operating speed has increased severity of abuse to plows, etc., when rocks, stumps, etc., are encountered.

In some industries we hear a great deal about the concept of "design for obsolescence." Technological advances have been going on in farm equipment for a long time. When a more efficient machine is produced or a labor-saving method introduced, it is readily accepted. This does not mean that the old equipment is scrapped before it is worn out. Dependability and durability are very important qualities in all farm machines.

We need to keep in mind that the cost of farm machinery is an increasingly big factor in agriculture. The farmer's investment in machinery is about three times greater on the basis of dollar production than it is in most other industries. When farm machinery costs get out of line with the general agricultural economy, it hurts both the farmer and the manufacturer. This is becoming an increasing responsibility for engineers. Their most urgent tasks now are to make farm machines as trouble free and long lasting as possible and to contribute as well to more efficient use of machines on the farm. Efficient machines as well as efficient use of machines are parallel in importance.

EVENTS CALENDAR

October 19-22 — Annual Conference of the *Soil Conservation Society of America*, to be held in the Auditorium of Asheville, N. C. The theme is Land and Water for Tomorrow's Living. For further information contact SCSA, 838 5th Ave., Des Moines, Ia.

October 20-22 — *Farm Electrification Conference* sponsored by the American Institute of Electrical Engineers at the Monteleone Hotel, New Orleans, La. For details write S. G. Dinkel, Chairman, General Electric Co., 1004 Richards Bldg., New Orleans 12, La.

October 20-24 — *46th National Safety Congress and Exposition*, to be held in Chicago. Farm Safety activities will be held October 21, 22 and 23 at the Hamilton Hotel. Further details may be obtained by contacting National Safety Council, 425 No. Michigan Ave., Chicago 11, Ill.

October 23-25 — *The National Society of Professional Engineers*, St. Francis Hotel, San Francisco, Calif. For details contact K. E. Trombley, National Society of Professional Engineers, 2029 K St. N.W., Washington 6, D.C.

November 17-21 — *8th National Plastics Exposition* and Annual National Conference of the *Society of the Plastics Industry, Inc.*, to be held at Chicago International Amphitheater. Additional information may be obtained by writing to National Plastics Exposition, 250 Park Ave., New York 17, N. Y.

December 3-5 — Eighth Annual Convention and Trade Show of the *Agricultural Ammonia Institute*, Morrison Hotel, Chicago. Write to J. F. Criswell, AAI, Claridge Hotel, Memphis Tenn., for information.

December 8-13 — *Dairy Industries Exposition*, on Navy Pier, Chicago. For details write to Dairy Industries Supply Association, 1145 19th St., N.W., Washington 6, D.C.

December 29-30 — Section M—Engineering portion of Annual Meeting of the *American Association for the Advancement of Science*, Hotel Statler, Washington, D.C. Program available after October 15 from Secretary, Section M, c/o E. J. C., 29 West 39th St., New York 18, N. Y.

February 2-4 — 1959 Meeting of the *Association of Southern Agricultural Workers* —Agronomy Section, Memphis, Tenn., at the Peabody Hotel. Contact Louis N. Wise, Secretary, Agronomy Section, Agronomy Dept., Mississippi State University, State College, Miss., for details.

PERSONNEL SERVICE BULLETIN

NOTE: In this bulletin, the following listings current and previously reported are not repeated in detail; for further information see the issue of AGRICULTURAL ENGINEERING indicated. "Agricultural Engineer" as used in these listings is not intended to imply any specific level of proficiency or registration as a professional engineer. Items published herein are summaries of mimeographed listings carried in the Personnel Service, copies of which will be furnished on request. To be listed in this Bulletin, request form for Personnel Service listing.

POSITIONS OPEN — MAY — O-129-814, 147-815, 69-817, 132-818, 132-819, 154-820, 159-822. JUNE — O-189-823, 194-824, 199-825, 200-826. JULY—O-256-827. AUGUST—O-276,830. SEPTEMBER—O-308-831.

POSITIONS WANTED — MAY — W-25-20, 127-21, 128-22, 143-23. JUNE — W-175-26, 186-27, 79-28, 192-29, 172-30, 205-31. JULY—W-197-32, 246-33, 251-35. AUGUST — W-258-38, 236-39, 260-40, 261-41, 242-42, 271-43, 286-44, 285-45, 287-46. SEPTEMBER—W-279-47, 297-48, 299-49, 248-50.

NEW POSITIONS OPEN

AGRICULTURAL ENGINEER (assistant) for extension work in a Northeastern state. Leadership primarily in power, machinery, 4-H, and safety phases of program. Additional responsibility for some work in most phases of agricultural engineering. MSAE or BSAE and experience. Age 25-36. Extension experience desirable. Aggressive leader able to get along well with others and enjoy meeting people. Excellent opportunity in newly created position, to be filled as soon as well qualified candidate is found. Several fringe benefits included or optional. Annual salary review and merit increases. Starting salary open. O-321-832

NEW POSITIONS WANTED

AGRICULTURAL ENGINEER for design, development, or research in power and machinery or soil and water field with industry or public service in West or Midwest. Limited travel. Married. Age 29. No disability. BSAE, 1952, Kansas State College. Farm background. Pregraduation experience as laboratory technician, assistant research chemist, and assistant research engineer. Service in USAF 2 yr. as maintenance and transport officer (ground vehicles), and as research and development officer. Instructor in college algebra 3 months before called to military service. Elementary school teaching, one year. Available on 30 days notice. Salary open. W-314-52

AGRICULTURAL ENGINEER for design, development, research or service in power and machinery or soil and water field with manufacturer, distributor, or consultant, any location. Single. Age 24. No disability. BSAE, 1955, North Dakota Agricultural College. Farm background. Five months in design with farm equipment manufacturer. Commissioned service in Air Force, 3 yr. to be completed January 1959, with training and experience as aircraft maintenance officer. Available February 15, 1959. Salary open. W-315-53

AGRICULTURAL ENGINEER for design in power and machinery with manufacturer. Any location. Married. Age. 35. No disability. BSAE, 1949, Univ. of Idaho. Farm background. Precollege army enlisted experience. Experience since 1950 in design of combines, sprayers, mowers, and materials handling equipment. One year teaching and graduate study. Available January 1. Salary open. W-322-54

MEMBERSHIP APPLICANTS

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Bond, William R. — Sr. district engr., American Wood Preservers Institute. (Mail) 1410 S. W. Morrison St., Portland 5, Ore.

Brown, Harold E. — Proj. engr., International Harvester Co. (Mail) 6611 67th St., Tinley Park, Ill.

Dahlgren, Lowell M. — Gen. mgr., Rolfes Grain Aeration Cos. (Mail) 1127 Crawford St., Boone, Iowa

Denny, Franklin D. R. — Rural service engr., Alabama Power Co., Oneonta, Ala.

Dressen, Paul A. — Power use advisor, Codington-Clark Electric Co-op., Inc. (Mail) 311 6th St., S.E., Watertown, S. D.

Elder, John C. — Agr. engr., (SCS) USDA, P.O. Box 788, Selma, Ala.

Elder, Lawrence L. — Mechanical engr., Sinton and Brown Co. (Mail) 180 Patterson Rd., Santa Maria, Calif.

Gray, Donald M. — Res. assoc., agr. eng. dept., Iowa State College, Ames, Iowa

Halkias, Nikolas A. — Head, studies dept., Land Reclamation Works of Macedonia. (Mail) 22, Angelaki St., Thessaloniki, Greece

Harre, Edwin A. — Technician, agr. eng. dept., Univ. of New Hampshire. (Mail) Mast Rd., R.R. 1, Durham, N. H.

Hathcock, Aaron A. — Power use advisor, Pee Dee Electric Membership Corp. (Mail) R.R. 3, Box 423, Wadesboro, N. C.

Johnson, Charles M. — Mgr., J. E. Johnson and Son, Farm Managers and Consultants. (Mail) P.O. Box 127, Monticello, Ill.

Kraft, William G. — Pres., Canadian Steel Fabricators Ltd., 1398 Eglinton Ave., W., Toronto, Ont., Canada

Middlecoff, Lawrence H. — Farmer, Somerville, Tenn.

Nystrom, Birger G. H. — Mgr., investigation dept., LBF (The Building Society of Swedish Farmer Assn.). (Mail) Gamla allen 19, Saltsjo Duvnas, Sweden

Peterson, Herbert A. — Instructor, agr. eng. dept., Pennsylvania State Univ., University Park, Pa.

Pfeiffer, William E. — Chief engr., Rolfes Grain Aeration Cos. (Mail) 1321 Story St., Boone, Iowa

Saunders, James R. — Agr. engr., Florida Power Corp., P.O. Box 4042, St. Petersburg, Fla.

Slowinski, Frank R. — Des., Champion Corp., 4714 Sheffield Ave., Hammond, Ind.

Thomas, Charles W. — Hydraulic engr., Bureau of Reclamation. (Mail) 825 Krameria St., Denver 20, Colo.

Williams, Don W. — Rural engr., VEPCO. (Mail) P.O. Box 646, Gloucester, Va.

TRANSFER OF MEMBERSHIP

Buelow, Frederick H. — Asst. prof., agr. eng. dept., Michigan State Univ., East Lansing, Mich. (Associate Member to Member)

Glover, John W. — Spec., agr. eng. ext., North Carolina State College. (Mail) 3008 Churchill Rd., Raleigh, N. C. (Associate Member to Member)

Oliver, Roland A. G. — Rural service engr., Alabama Power Co. (Mail) P.O. Box 231, Jasper, Ala. (Associate Member to Member)

Shepard, Francis D. — Rural service rep., Niagara Mohawk Power Corp. (Mail) R.R. 2, Warboys Rd., Byron, N. Y. (Associate Member to Member)

Wagner, William V., Jr. — Agr. engr., Portland Cement Assoc. (Mail) 1437 Deerfield Rd., Deerfield, Ill. (Affiliate to Member)

Whisenant, Dewey A. — Staff engr., Goodyear Tire and Rubber Co. (Mail) 415 Hood Ave., East Gadsden, Ala. (Associate Member to Member)

Witmuss, Howard D. — Assoc. prof., agr. eng. dept., Univ. of Nebraska, Lincoln 3, Nebr. (Associate Member to Member)

STUDENT TRANSFERS

Battenberg, Jacob T., Jr. — (Univ. of Missouri) Farm sales rep., MonMac Builders Inc. (Mail) 10404 E. 59th St., Raytown, Mo.

Bollinger, Charles E. — (Oklahoma State Univ.) (SCS) USDA. (Mail) P.O. Box 164, Valliant, Okla.

Gastel, James F. — (Univ. of Illinois) (Mail) R.R. 1, Freeport, Ill.

Parker, Rayburn E. — (Mississippi State Univ.). (Mail) Vance, Miss.

Quesada, Jaime L. — (A & M College of Texas) (Mail) 10 Nunez de Balboa, Madrid, Spain

Reeves, Bobby F. — (A & M College of Texas) Agr. engr., (SCS) USDA. (Mail) Eagle Pass, Tex.

Index to Advertisers

ADVERTISING REPRESENTATIVES

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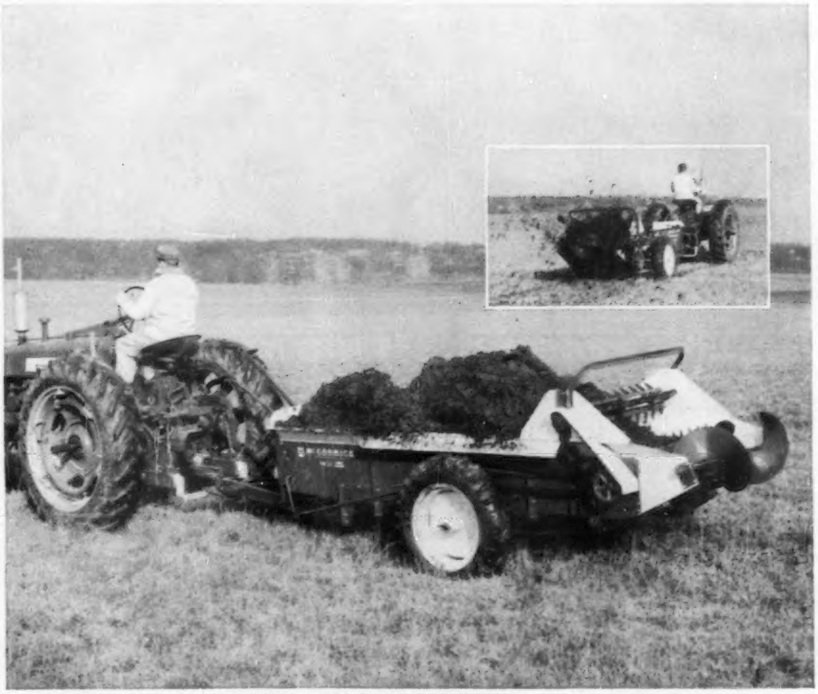
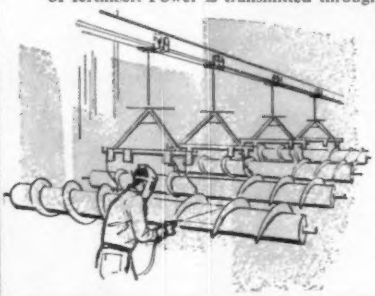
Advertising Manager: RAYMOND OLNEY, 420 Main St., St. Joseph, Mich. YUkon 3-2700

What LINK-BELT augers contribute to the design of your machines



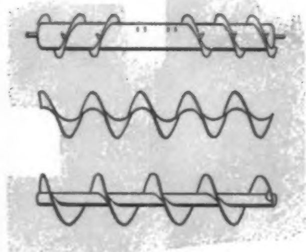
INTERNATIONAL HARVESTER COMPANY MANURE SPREADERS use Link-Belt right and left hand sections of flighting, mounted on a common shaft, to provide widespread distribution of fertilizer. Power is transmitted through Link-Belt chains and sprockets.

LATEST MACHINES AND METHODS assure auger uniformity, accuracy. Sheets for tubing are jig punched, then rolled to be true round. Flighting is cold rolled for slip fit on tubing and welded for permanent alignment.



QUALITY "SAFEGUARDS" make sure all Link-Belt augers are delivered in perfect operating condition. Straightness is carefully checked before shipping . . . painting prevents rusting . . . extra care is taken in handling, loading.

SELECTED FLIGHTING is available from Link-Belt to meet any auger application — helicoid, cut flight, short pitch, ribbon flight, double flight and many other designs — in the metal and finish best suited for your requirements.



. . . and why they're the consistent choice of leading farm machine manufacturers

Simplicity, strength, exactness of construction—all are combined in Link-Belt augers to assure long-lived, dependable performance on your machine.

Every Link-Belt auger is a uniform, smooth, accurately rolled product . . . one sturdy, compact basic assembly with no other moving parts to cause excessive maintenance. Only selected steels are used, and Link-Belt's modern, specialized machinery achieves consistent flighting uniformity.

Link-Belt offers augers in a full range of diameters, gauges and pitches. For details, call or write your nearest Link-Belt office. Ask for Book 2289.

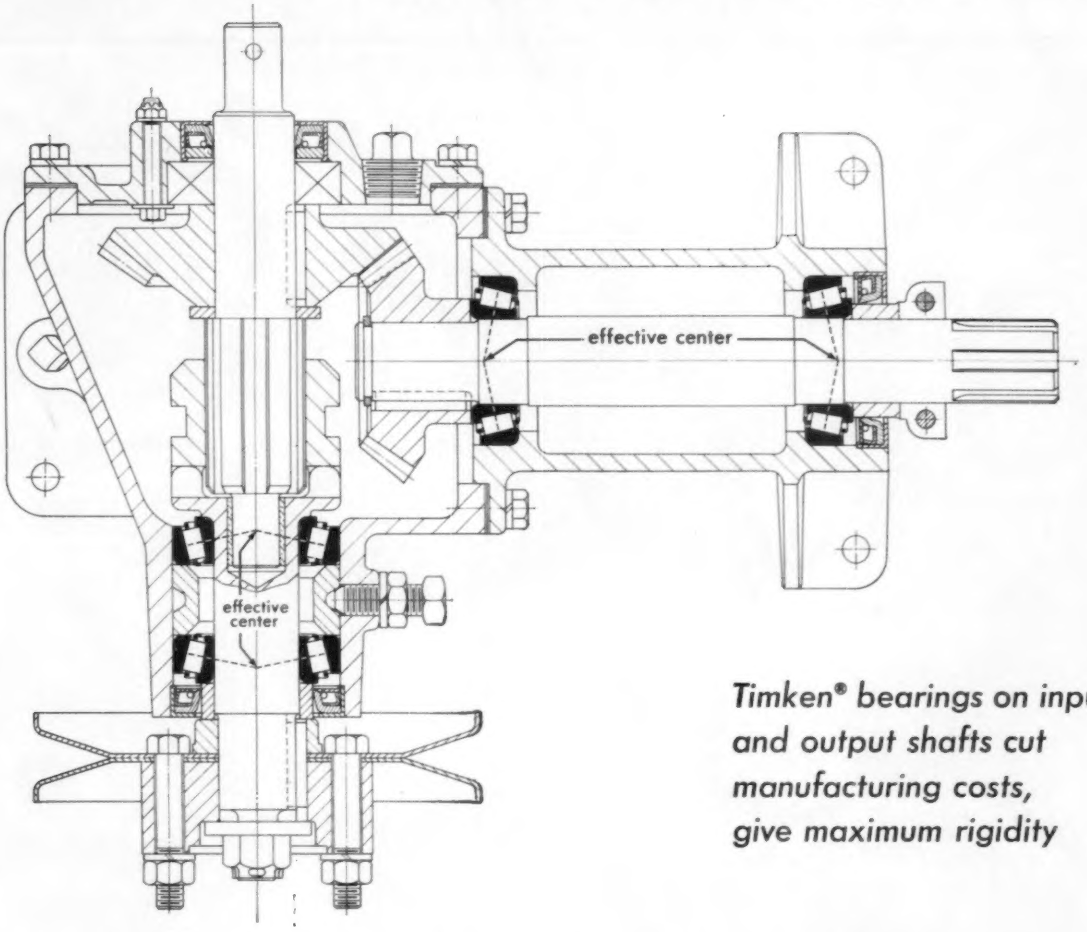
LINK-BELT

FARM MACHINE AUGERS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs. Representatives Throughout the World. 14,929

(For more facts circle No. 48 on reply card)

Allis-Chalmers engineers get maximum design economies with all-TIMKEN-bearing gear box



Timken® bearings on input and output shafts cut manufacturing costs, give maximum rigidity

ALLIS-CHALMERS engineers wanted to use indirect bearing mountings on both the input and output shafts in the gear box of their Model 90 ALL-CROP harvester. This would enable them to take advantage of the effective spread principle of Timken bearings (illustrated above)—obtain maximum shaft and gear rigidity. They saved costly manufacturing steps and here's how:

1) By using a simple, split collar for bearing adjustment and a snap-ring at the bevel pinion, costly drilling and tapping or threading of the input shaft was eliminated.
2) The simplified mounting of the Timken bearings on the output shaft made possible a bench assembly which facilitated bearing adjustment by simply using the nut at the end of the shaft. The bearing assembly is located in the housing through the use of a grooved cup spacer and set screw, permitting through-boring of the housing.

Simpler and more compact designs are big reasons why more and more engineers are standardizing on Timken bearings. Tapered construction lets Timken bearings take any combination of radial and thrust loads. Full-line contact between rollers and races gives Timken bearings *extra* load-carrying capacity. Shafts are held concentric with housings—making closures more effective. Dirt stays out; lubricant stays in. Timken bearings enable agricultural engineers to lick their three biggest problems: 1) combination loads, 2) dirt, 3) ease of operation—give the farmer a better, more economical machine.

For help in designing *your* new bearing applications, contact our sales engineers or write The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

NOT JUST A BALL ◯ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL AND THRUST -- LOADS OR ANY COMBINATION

The farmer's assurance of better design

TIMKEN Tapered Roller BEARING EQUIPPED

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